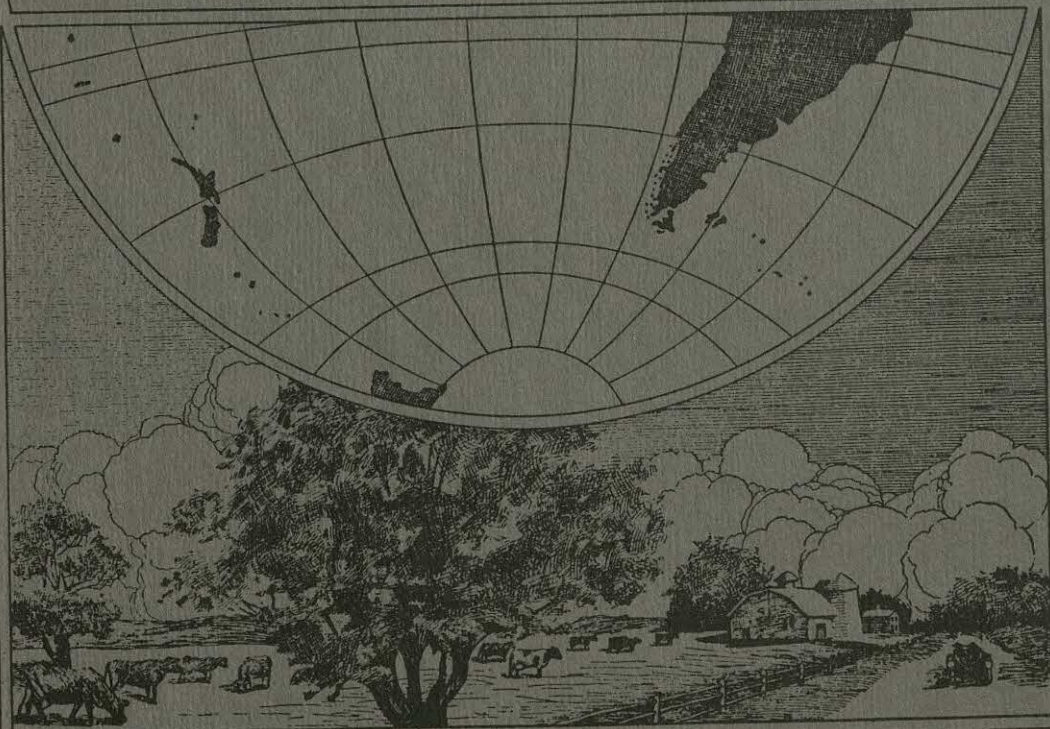
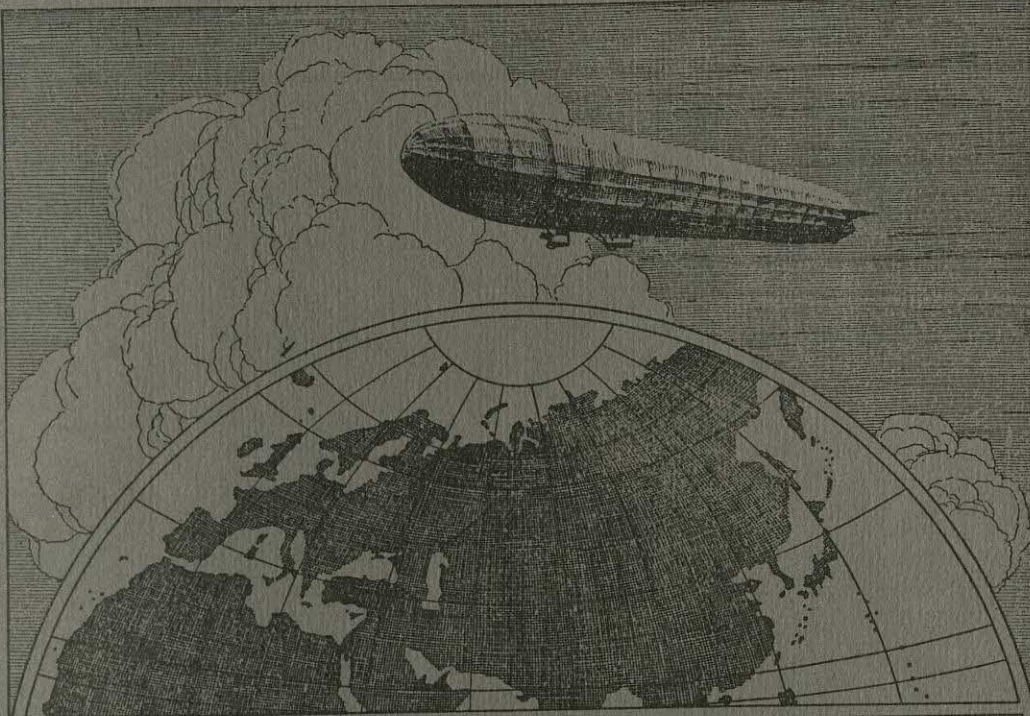




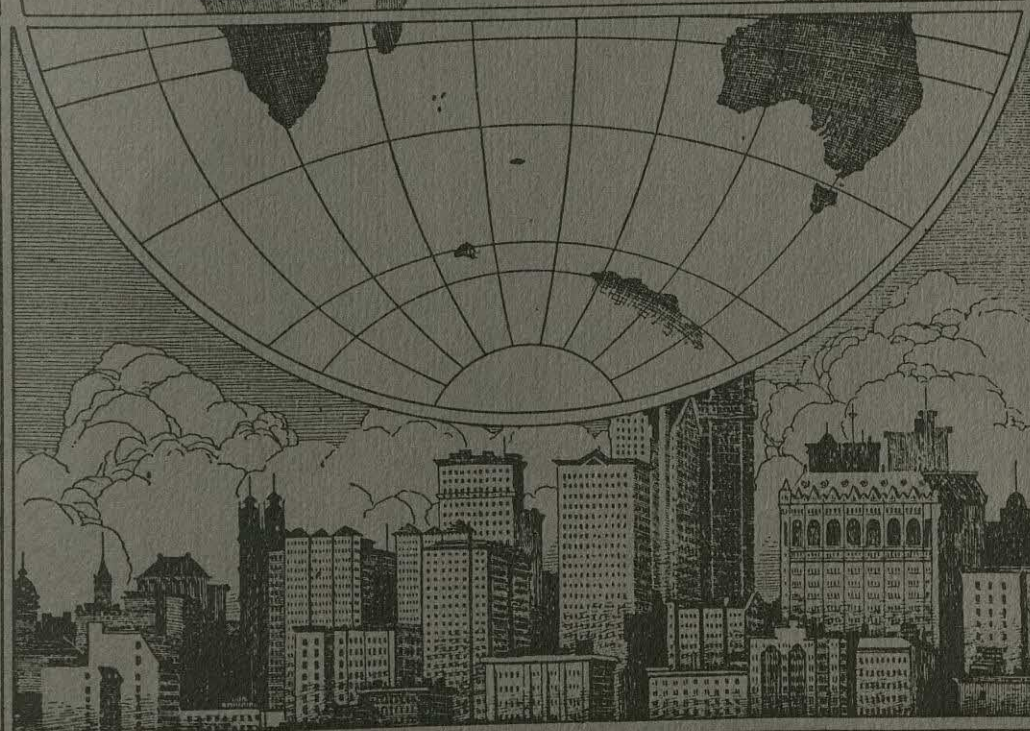


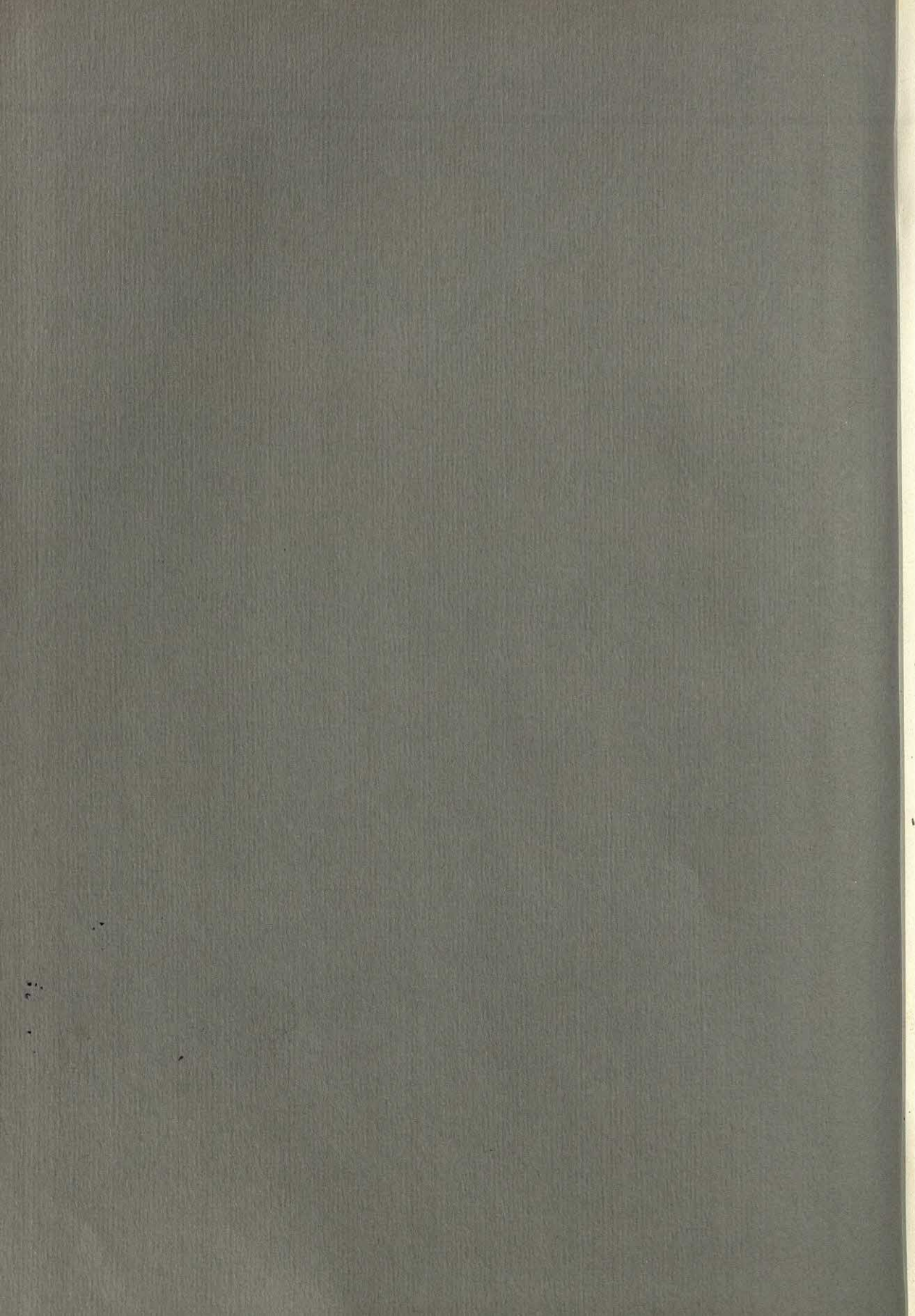
THE WORLD BOOK





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S-Sn Volume 17

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The World Book Encyclopedia



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Ss

S is the 19th letter in the English alphabet. It was also a letter in the alphabet of the ancient Semites, who once lived in Syria and Palestine. They called the letter *shin*, meaning tooth. The Phoenicians took over the Semitic letter and gave it a more regular shape, and the Greeks turned it on its side. See **Alphabet**.

Uses. *S* or *s* is about the eighth most frequently used letter in books, newspapers, and other printed material in English. As a geographic abbreviation, it stands for *south* or *southern*. As an abbreviation in titles, *S* often means *society*, *state*, or *school*. In music, *s* is used as an abbreviation for *soprano* or *solo*. In geology and physics, it stands for *surface* wave. It stands for the element *sulphur* in chemistry, and for *singular* number in gram-

mar textbooks and in dictionaries. Letter *s* is also used as an abbreviation for *size* in advertisements and catalogues.

Pronunciation. *S* has two common sounds in English. It can have a voiceless, hissing sound, as in *sat*. A person produces this sound by forcing the breath through the open lips with the tongue below the lower teethridge and the vocal cords relaxed. *S* can be pronounced as *z* in the middle or at the end of a word (*season*, *has*). This sound is produced in much the same way, but with the vocal cords vibrating. In such words as *aisle* or *debris*, the *s* is silent. *S* has the same sounds in French, German, and most other European languages that it has in English.

Development of the letter S



The ancient Egyptians drew this symbol of a tusk about 3000 B.C.



The Semites, about 1500 B.C., developed a letter they called *shin*, which was their word for *tooth*.



The Phoenicians squared off the letter about 1000 B.C.



The Greeks, about 600 B.C., turned the letter on its side and called it *sigma*.



The Romans gave the letter *S* its capital form about A.D. 114.

The small letter *s* developed during the A.D. 500's from Roman writing. By the 1500's, the letter had the form that is used today.



A.D. 500

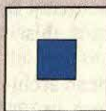


1500

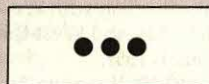


Today

Special ways of expressing the letter S



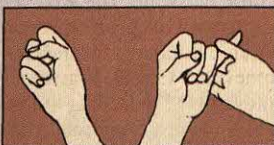
International Flag Code



International Morse Code



Braille



American Sign Language

British Sign Language



Semaphore Code

Common forms of the letter S

Ss *ss*

Ss *Ss*

Handwritten letters vary from person to person. *Manuscript* (printed) letters, *left*, have simple curves and straight lines. Cursive letters, *right*, have flowing lines.

Roman letters have small finishing strokes called *serifs* that extend from the main strokes. The type face shown above is Baskerville. The italic form appears on the right.

Ss *Ss*

Sans-serif letters are also called *gothic letters*. They have no serifs. The type face shown above is Futura. The italic form of Futura appears on the right.

S

Computer letters have special shapes. Computers can "read" these letters either optically or by means of the magnetic ink with which the letters may be printed.

Saadi (1213?-1292) was a famous Persian author who wrote works in both prose and poetry. His best-known work is the *Golestan* (*Rose Garden*), a collection of prose tales with moralizing verses attached. Saadi's writings are characterized by a clear and modest style, and by a tolerance and humanity of sentiment. The clarity and high moral quality of his work have made him perhaps the most popular of all Persian writers.

Saadi was born in Shiraz. He lived in politically unstable times and spent much of his life moving from place to place and patron to patron.

Saar is a state in Germany on the Franco-German border (see **Germany** [political map]). The Saar covers 2,574 square kilometres and has a population of 1,045,900. It is named after the Saar River, which flows through the area. The region is also called the Saar Territory, or the Saar Basin. The German name for the Saar is *Saarland*. The Saar is valuable for its many coal mines and steel plants. Its capital is Saarbrücken.

Before World War I, the Saar belonged to Germany. After the war, France wanted to annex the Saar in payment for war damages. The Treaty of Versailles gave France the use of the Saar coal mines for 15 years in payment for French losses. The League of Nations governed the Saar during the French occupation. The governing body included one French citizen, one German, and three people of other nationalities. Germany protested, and in 1930 the League ordered an end to the allied control. Most of the region's people were Germans, and they voted in 1935 to become part of Germany.

As a result of Germany's defeat in World War II, France occupied the Saar in 1945. France directed the region's defence and foreign relations and controlled its heavy industries. The Saar also joined in a customs and currency union with France. The Saar was allowed partial self-government in 1947. In October 1955, the people voted against transferring the responsibilities of defence and foreign relations from France to the Western European Union. On Dec. 18, 1955, they elected a parliament pledged to unite the Saar with West Germany. By agreement between France and West Germany, this union occurred on Jan. 1, 1957.

Saarinén, Eero (1910-1961), was an American architect noted for his daring use of sculptural form. In 1948, his design of a giant stainless steel arch won a competition for a memorial in St. Louis, Missouri. The arch was completed in 1965. Saarinen gained his greatest recognition for his boxlike steel-frame buildings for the General Motors Technical Center (1945-1956) in Warren, Michigan. His Kresge Auditorium (1953-1956) at the Massachusetts Institute of Technology is a reinforced concrete dome with only three points of support. Saarinen's Trans World Airlines Terminal (1956-1962) at Kennedy International Airport in New York City uses winglike forms of reinforced concrete.

Saarinén was born in Kirkkonummi, near Helsinki, Finland. He moved to the United States in 1923. From 1937 to 1950, he worked with his father, Eliel, who was also a famous architect.

For examples of Eero's designs, see **Architecture** (An airline terminal); **Furniture** (Classics of modern furniture design); **Interior decoration** (Form in interior design).

Saarinén, Eliel (1873-1950), was a Finnish-born architect. He became internationally famous for the bold and

simplified traditional design of his Helsinki railway station (1904-1914).

In 1923, Saarinen settled in the United States. In 1924, he began designing the buildings for what is now the Cranbrook Educational Community, a complex of schools in Bloomfield Hills, Michigan. He was president of the Cranbrook Academy of Art from 1932 to 1946. From 1936 until his death, Saarinen worked with his son, Eero. But Eliel is chiefly credited with two of their finest works—the Tabernacle Church of Christ (1939-1942) in Columbus, Indiana, and the Christ Lutheran Church (1947-1950) in Minneapolis, Minnesota. Saarinen was born in Rantasalmi, near Varkaus.

Saavedra Lamas, Carlos. See **Nobel Prizes** (table: Prizes for peace—1936).

Saba (pop. 1,116) is one of the islands in the northern group of the Netherlands Antilles. It is the most westerly island in the northern group, lying west of St. Eustatius, its nearest neighbour. Saba is an extinct volcano rising 915 metres above the surface of the sea. It has an area of 13 square kilometres. The climate is tropical, tempered by northeast trade winds.

Saba is primarily a tourist centre. It is a stop-over point for cruise liners. Fort Bay has a deep-water pier. A commuter ferry and air service operate between Saba and Saint Martin. Saba's capital is a community called the Bottom. The island's population is evenly divided between people of African origin and people of English or Dutch origin. English is the common language.

Sabah is the second largest state in Malaysia. It lies on the northeastern part of the island of Borneo. Sabah is mainly rural, with large areas of forest and mountain. Most people live in towns and in small villages.

People and government

There are 30 separate ethnic groups of people in Sabah. The largest are the Kadazans, Bajaus, and Muruts. Smaller groups include the Bisayah, Orang Sungai, Kedayan, Idahan, Rangus, Tidong, Suluk, and Brunei. Each group lives in specific districts and has its own religion, language, and dress.

Political instability in the southern Philippines in the early 1970s brought many refugees to the state. Large numbers of Indonesian and Filipino workers entered the state in search of employment. They make up a considerable proportion of the population.



Sabah is a mountainous, forest-covered state on the northeast coast of the island of Borneo.



The flag of Sabah, in the five state colours, includes a silhouette of Mount Kinabalu. The state coat of arms, right, has a shield with the same silhouette. The state motto, *Sabah Maju Jaya*, means Let Sabah Prosper.



The head of state of Sabah is the *yang di-pertua negeri* (governor). The state government consists of a state cabinet with a chief minister, 8 other ministers, 14 assistant ministers, and a state legislative assembly with 48 elected and six nominated members. The state administration is made up of the chief minister's department and eight other ministries, each overseeing a number of departments and agencies. The state is divided into five divisions, 23 districts, and 5 sub-districts. See also Malaysia, Government of.

Economy

The mining and timber industries form the basis of Sabah's economy. Agriculture is of less importance and manufacturing is still relatively unimportant.

Sabah is the third most important producer of petroleum and natural gas in Malaysia. It produces about 60,000 barrels per day. The natural gas generates electricity which fuels a hot briquetted iron plant and a methanol plant on Labuan Island.

The state also operates the largest copper mine in the country. This is the Mamut mine which is 1,400 metres above sea level, south of Mount Kinabalu. The mining industry contributes 40 per cent of Sabah's exports.

The state is equally rich in timber resources. Logs, plywood, sawn timber, and veneer account for another 30 per cent of exports.

The chief crops in Sabah are cocoa, oil palm, and rubber. Since the 1960's, oil palm and, later, cocoa have replaced rubber as the major crops. Together they account for 12 per cent of the state's exports.

The main industrial products are hot briquette iron and methanol on Labuan, timber in the various sawmills, and consumer goods in the industrial estates of Kota Kinabalu, Sandakan, and Tawau.

Land

Sabah's eastern and northeastern coastlines face the Philippine islands in the Sulu Sea. The northwest coast is on the South China Sea. To the west is the Malaysian state of Sarawak, and to the south is the Indonesian territory of Kalimantan, which occupies about two-thirds of the island. Sabah consists of three distinct zones: the coastal swamps, the plains, and the uplands and mountains. Sabah is dominated by a series of mountain ranges and highlands, and mountains and steep slopes cover nearly half the land area.

The Crocker Range runs parallel to the west coast, from the Sarawak border to the north. It forms a barrier

Facts in brief about Sabah

Population: 1991 census — 1,736,902.

Area: 73,710 km².

Capital: Kota Kinabalu.

Largest towns: Kota Kinabalu, Sandakan, Tawau, Lahat Datu.

Chief products: Agriculture—cocoa, palm oil, rubber, timber.

Mining—copper, natural gas, petroleum.

to movement to the interior and to the east coast. Mount Kinabalu (4,100 metres) in the range is the highest peak in Southeast Asia. A few other peaks exceed 2,000 metres. The rugged western foothills of the Crocker Range restrict the coastal lowland to a few isolated pockets. To the east of the Crocker Range is a series of plains which contain the towns of Ranau, Tambunan, Keningau, and Tenom. On the southeastern flank of Mount Kinabalu is the Pinosuk Plateau, a deeply grooved, sloping plain about 1,500 metres above sea level.

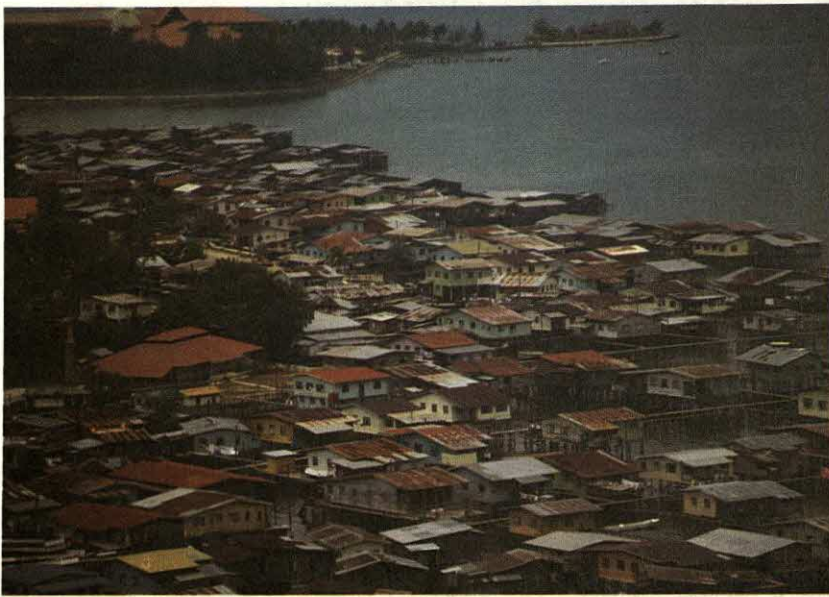
The rugged Trus Madi Range, with a maximum height of 2,600 metres, flanks the eastern side of the Tambunan and Keningau Plains. The Witt Range forms the eastern flank of Tenom Plain. In between these ranges is the Sook Plain. The Central Uplands comprise the highlands of Labuk, Kuamut, Segama, and Tawau.

The Kuamut Highlands form the catchment area of the major tributaries of the state's largest river, the Kinabatangan. The highlands are among the most remote, inaccessible, unexplored, and uninhabited areas of Sabah. The region consists of a series of ridges which rise to 1,600 metres. The Segama Highlands are moderately high, and the Tawau Highlands to the south rise to over 1,300 metres at Mount Magdalene.

The Pegalau and Tenom rivers drain Tambunan and Keningau plains. The Pegalan and Tomani rivers join at Tenom town and become the Padas. The Padas River turns northwestward, cutting a gorge through the Crocker Range. The gorge provided, until recent years, the only route through which overland transport could pass between the coast and the interior. The Liwagu River is a tributary of the Labuk, one of the major rivers in the east of Sabah.



Mount Kinabalu in western Sabah, is a barren plateau above granite cliffs. It is often hidden in clouds.



Traditional houses in Malaysia are raised on stilts to provide natural protection against floods and predators. This coastal kampong at Kota Kinabalu, Sabah, has grown by building outwards over the water.

The equatorial climate of Sabah is hot and humid. Like other tropical areas, the difference in temperatures between day and night is much higher than between seasons. The mean temperatures are high and consistent throughout the year. At sea level, the mean temperature varies from 25° to 31° C. In the uplands, average temperatures may drop to 20° C.

History

Brunei gave the east coast of Sabah to the sultans of Sulu in 1704 in return for favours in a succession dispute. Sabah (known as North Borneo until 1963) was visited by several western adventurers in the late 1800's. Joseph William Torrey, an American trader, obtained from the feeble Brunei sultanate a lease over the greater part of the territory. This lease was later transferred to Gustavus de Overbeck, an Austrian baron, and finally to Alfred Dent, an English businessman. Dent signed treaties with both the sultans of Brunei and Sulu, gaining complete control of the territory. In 1881, he succeeded in establishing the Chartered Company of British North Borneo to manage the territory. The region fell to the Japanese in 1941. After World War II ended in 1945, the territory was a British Crown Colony until it achieved independence by becoming part of Malaysia in 1963.

See also **Malaysia; Borneo**.

Places to visit

Following are brief descriptions of some of the interesting places to visit in Sabah.

Gomantong Caves, south of Sandakan, are famous for the edible nests of swiftlets. These nests are highly prized as a Chinese delicacy. People climb as much as 90 metres up bamboo ladders to harvest the nests twice a year.

Mount Kinabalu is in the Kinabalu National Park. It is a popular tourist resort. The Kadazan people regard the mountain as the homeland of their spirits and the home of their dead. It contains over 800 species of orchids, 500 species of birds and the world's largest flower, the *rafflesia*.

Sabah, Shaykh Jabir al-Ahmad al- (1926-), became *amir* (commander) of Kuwait in 1977. He was the third son of Shaykh Ahmad al-Jabir, who ruled Kuwait from 1921 to 1950.

His first major public responsibility concerned the Kuwait Oil Company, which he headed from 1950 to 1954. From 1960 to 1964, he was involved in a broad range of financial and economic matters. He became prime minister in 1965 and was named heir apparent in 1966. Sabah served again as prime minister in 1977. In December 1977, he succeeded his father as *amir*. In 1981, he restored parliament, which had been suspended in 1976. But he suspended it again in 1986. When Iraq invaded Kuwait in August 1990, Sabah escaped to Saudi Arabia. He returned to Kuwait in March 1991 after the Iraqi forces had been driven out (see **Kuwait** [History]).

Sabbath is the rest day of the Jews. It falls on Saturday, the seventh day of the week. Today, Christians also use the word *Sabbath* for their Sunday.

In Biblical times, the Sabbath was a joyous, holy day. People stopped working, visited the Temple, and offered extra sacrifices. One of the Ten Commandments (Exod. 20:8-11) requires resting on the Sabbath.

Jews took observance of the Sabbath seriously. They suffered many losses and insults rather than break the Sabbath laws. In the Oral Law, 39 kinds of labour were forbidden. These included the procedures related to growing, preparing, and cooking food; weaving and making clothes; slaughtering animals and preparing hides; writing; building; carrying things from one location to another; and lighting fires.

Many Jews still keep strict Sabbath regulations. Their Sabbath lasts from sunset on Friday evening until sunset on Saturday. Christians have generally adopted Sunday as the Sabbath because they believe that Jesus Christ rose from the dead on Sunday (see **Sunday**). But the Seventh-day Adventists, a Christian denomination, observe Saturday as the Sabbath.

See also **Judaism** (The Sabbath).

Sabin, Albert Bruce (1906-1993), an American medical researcher, developed the oral polio vaccine. The Sabin vaccine consists of weakened forms of the viruses that cause polio. It protects the body against polio without causing the disease.

Doctors in the United States began to use the vaccine in 1961, the year after Sabin developed it. Previously, vaccinations against polio had to be given by injection. The Sabin vaccine is easier to give than the earlier vaccine, developed by Jonas Salk in 1954, and its effects last longer. The widespread use of both types of vaccines has nearly eliminated polio in many regions of the world. Sabin also developed vaccines against other virus diseases, including encephalitis and dengue. In addition, he investigated possible links between viruses and some forms of cancer.

Sabin was born in Poland. His family settled in the United States in 1921, and he graduated from the New York University College of Medicine in 1931. Sabin served on the staffs of many medical institutions, including the University of Cincinnati College of Medicine and the Medical University of South Carolina. He received many awards for his research.

See also **Poliomyelitis**; **Salk, Jonas Edward**.

Sabines were members of an ancient Italian tribe. The Sabines lived northeast of Rome, and were among the ancestors of the Romans.

The Sabines are famous for a legend told about them. According to the legend, no women lived in Rome when Romulus founded the city. Romulus asked neighbouring cities to allow Romans to choose wives from among their women. When the cities refused, Romulus invited all the surrounding people to attend a great festival. During the festival games, the Romans carried off young Sabine women by force. The Sabines went to war with the Romans, but the women persuaded the two tribes to stop fighting and unite as one nation.

Sable is a small animal in the weasel family. Sables range from eastern Russia across Siberia and Mongolia to Hokkaido, in northern Japan. They are closely related to North American *pine martens*, also called *American sables* (see **Marten**).

The sable is about 50 centimetres long, including its 13-centimetre tail. Its fur ranges from dark brown to almost black, with a greyish-yellow patch on the throat. The coat of the sable does not change to white in winter, as do those of some animals. Furriers make it into expensive clothing (see **Fur**).

Because of the demand for the fur, trappers have

killed off the animals in the western and southwestern portions of the Russian range. Sables are rare almost everywhere. The Russian government has closed the trapping season several times, and has experimented successfully with rearing sables.

Scientific classification. The sable belongs to the family Mustelidae. It is *Martes zibellina*.

Sabotage is any means of deliberately wasting or damaging the tools, machinery, or production of an employer or government. The word originated in the 1800's when French workers would throw their *sabots* (wooden shoes) into machines to halt production. In Spain, France, and Italy, sabotage was used by the *syndicalists*, members of anarchist trade unions.

In wartime, sabotage by trained agents called *saboteurs* is a means of damaging war production and communications in enemy countries. Factories, railways, and dams are sometimes damaged purposely to deter enemy advance.

Since World War II ended in 1945, a number of countries have used sabotage in *covert* (secret) wars to intimidate, destabilize, or overthrow other governments. Such sabotage sometimes begins as an extension of intelligence activities between hostile states that are formally at peace (see **Intelligence service**).

See also **Fifth column**.

Sabre. See **Fencing**.

Sabre-toothed tiger was a catlike prehistoric animal. It was one of many catlike species that had enlarged *canine teeth* (long, pointed teeth near the front of the mouth). The teeth were shaped like *sabres* (curved swords), and were about 20 centimetres long. The first sabre-toothed tigers lived about 40 million years ago. They became extinct about 10,000 years ago. Fossils



The sabre-toothed tiger, a prehistoric animal, had two long, fanglike teeth that helped it catch and eat its prey.

have been found in Africa, Europe, and North and South America. The tigers were probably as heavy as today's tigers. They probably ate thick-skinned animals, including elephants, mastodons, and ground sloths.

Scientific classification. Some species of sabre-toothed tigers belong to the cat family, Felidae. Others belong to Nimravidae, an extinct family. The best known type belongs to the genus *Smilodon*.

Sacagawea (1787?-1812) was a Shoshone Indian woman who accompanied the Lewis and Clark expedition in 1805 and 1806. The expedition, an early exploration of the Northwestern United States, was led by U.S.



The sable is a rare animal that is native to Siberia. Sables are bred and reared on sable farms for their luxurious fur.

6 Saccharides

Army officers Meriwether Lewis and William Clark. Sacagawea has often been depicted in art and literature as the expedition's heroic guide. But in reality, her contributions, though important, were much more limited. Sacagawea's name means *Bird Woman*. It is also spelled *Sacajawea*.

Sacagawea joined the expedition in what is now North Dakota, after Lewis and Clark had hired her husband as an interpreter during the winter of 1804-1805.



Sacagawea has often been depicted in art and fiction as the heroic guide of the Lewis and Clark expedition. But her actual role—partly that of an interpreter—was much more limited.

Her husband was a French-Canadian trader named Toussaint Charbonneau. Lewis and Clark thought Sacagawea might be helpful when the expedition reached Shoshone territory in the Rocky Mountains.

In the Rockies in August 1805, the explorers met a band of Shoshone Indians whose chief was Sacagawea's brother. Sacagawea aided in communication between the Shoshone and the explorers. She also helped secure horses from the tribe for the explorers. Monuments and memorials have been named after Sacagawea.

See also **Lewis and Clark expedition**.

Saccharides are carbohydrates—one of the three main classes of food. Fats and proteins form the other two classes. Saccharides are classified according to their chemical structure. *Monosaccharides*, which have the simplest structure, include *glucose*, a sugar found in the blood. Monosaccharides, unlike other saccharides, cannot be broken down into simpler carbohydrates by treatment with dilute acids or by the action of certain enzymes. *Disaccharides*, such as *sucrose* (table sugar), consist of two monosaccharide molecules linked by an oxygen atom. *Polysaccharides*, such as starch and cellulose, may consist of thousands of linked monosaccharides. For a diagram of saccharide molecules, see **Carbohydrate**.

See also **Starch**.

Saccharin is a synthetic sweetener. It is made from toluene and petroleum. It is about 300 times as sweet as table sugar but has no carbohydrates and no food value. Saccharin also has a bitter aftertaste.

Saccharin has been widely used in place of sugar by people dieting to lose weight and by people with diabetes. It is made in the form of tiny tablets or as a powder or a liquid. Manufacturers use saccharin in such products as low-calorie soft drinks, sugarless chewing gum, jams, jellies, puddings, and salad dressings. Tests on saccharin have suggested that it could cause cancer in some cases.

Saccharin was discovered in 1879 by Constantin Fahlberg, a chemist at Johns Hopkins University. It has been sold commercially since about 1900. Its chemical formula is $C_6H_5SO_2NHCO$.

See also **Artificial sweetener**.

Sachs, Julius von (1832-1897), a German botanist, was the founder of the science of plant physiology. His influential *Textbook of Botany* (1868) emphasized the use of living plants in teaching botany. His *History of Botany* (1875) is one of the best sources of information about all aspects of botany up to 1860. Sachs was born in Breslau, Germany (now Wrocław, Poland).

Sachs, Nelly (1891-1970), was a German-born Jewish poet and dramatist. She shared the 1966 Nobel Prize for literature with the Israeli writer Shmuel Yosef Agnon. The Nobel judges honoured Sachs's "outstanding lyrical and dramatic writing, which interprets Israel's destiny with touching strength." Most of her poetry deals with persecution and agonies endured by the Jewish people for hundreds of years.

Sachs was born and educated in Berlin. Her first published work was *Legends and Tales* (1921), a collection of short stories. In 1940, during World War II, she fled to Sweden to avoid persecution of Jews by the Nazis in Germany. After World War II, Sachs wrote poetry about the Holocaust—the mass murder of European Jews by the Nazis. Sachs wrote in German. English translations of many of her poems are contained in *O the Chimneys* (1967) and *The Seeker and Other Poems* (1970). Her best-known play is *Eli: A Mystery Play of the Sufferings of Israel* (1950).

Sackville-West, Victoria Mary (1892-1962), was an English writer whose books reflect her aristocratic, country family background. Her best-known novel, *The Edwardians* (1930), examines English upper-class life during the reign of Edward VII in the early 1900's. Set against a background of country estates, the book tries to capture the social and emotional flavour of the time. She also wrote of country living in the novels *All Passion Spent* (1931) and *The Dark Island* (1934); in the nonfiction books *Country Notes* (1939), *English Country Houses* (1941), and *In Your Garden* (1951); and in many poems. Her best-known book of poetry is *The Land* (1929).

Victoria Sackville-West was born in Knole House, a country house given to her ancestors by Queen Elizabeth I. She travelled widely with her husband, diplomat-author Sir Harold Nicolson. Their son Nigel described their marriage in *Portrait of a Marriage* (1973).

Sacrament, in Christianity, is a solemn observance. It is an outward sign that a faithful worshipper is receiving the grace of God. The various Christian churches recognize different numbers of sacraments. The Roman Cath-

olic and Eastern Orthodox churches have seven sacraments—baptism, confirmation, Eucharist, penance (also called *confession*), anointing of the sick, holy orders, and matrimony. Most Protestant churches recognize two sacraments—baptism and Communion (also called the Lord's Supper). Quakers do not observe outward forms, but consider all life a sacrament. Roman Catholics believe that sacraments aid salvation. Protestants observe sacraments in services involving many people, but most Protestants see them as signs of agreement between God and individuals.

Related articles in *World Book* include:

Anointing of the Sick	Marriage
Baptism	Protestantism (Belief in sacraments)
Communion	Roman Catholic Church (The seven sacraments)
Confirmation	
Eastern Orthodox Churches (Sacraments)	

Sacramento (pop. 369,365; met. area pop. 1,481,102) is the capital of the state of California in the United States and the commercial centre of a rich farming region. It lies at the junction of the Sacramento and American rivers in California's Sacramento Valley, about 135 kilometres northeast of San Francisco.

Sacramento's economy depends heavily on governmental operations. The city has over 300 manufacturing plants. Rocket engine production and food processing rank as leading industries in the area.

Sacred College. See **Pope** (The election of a pope).

Sacred Heart of Jesus, Society of the, is a Roman Catholic society of women, established for the education of youth and to provide centres for retreats. It was founded in Paris in 1800 by St. Madeleine Sophie Barat. It has 188 houses, which include colleges, academies, and elementary and high schools. The schools are in 32 countries throughout the world, including the United States, Canada, and Mexico. The mother house is in Rome.

Sacrifice is a religious ceremony in which something is given to a god or the gods, thus becoming "holy." The word comes from two Latin terms meaning to *make holy*. People offering the sacrifice often expect to receive some physical or spiritual good, and to achieve a proper relationship with the sacred power. Sacrifices have included food, animals, and even human beings.

There are many theories about the origin of sacrifice. Some people claim that it was divinely instituted. Others believe that it developed from people's inner conflicts, uncertainties, or feelings of guilt and remorse. Still others believe that the sacrificed object occupies a middle space between humanity and sacred beings, thus connecting them.

Many religions include a ritual of sacrifice, often symbolically. Orthodox Christianity teaches that the sacrifice of Jesus makes other sacrifices unnecessary. The Jews have not used sacrifice since A.D. 70, when the Temple in Jerusalem was destroyed. Some religions, such as Buddhism, oppose sacrifice.

See also **Altar**; **Aztec (Religion)**; **Mythology** (American Indian).

Sacroiliac joint connects the backbone with the pelvis. The V-shaped sacrum bone near the bottom of the backbone fits like a wedge between the wide wings of the *ilium* (hipbone). Ligaments and plates made up of

cartilage connect the bones. Inflammation or strain on the joint often causes aching in the lower back.

Sadat, Anwar el- (1918-1981), was president of Egypt from 1970 until his death in 1981. Under Sadat's leadership, Egypt negotiated with Israel to end the longstanding conflict between the two countries. Sadat won widespread admiration for his peacemaking efforts, but he was severely criticized by other Arab leaders for negotiating independently. Sadat was assassinated in Cairo on Oct. 6, 1981, by a group of Egyptian religious militants who opposed his policies.

Sadat became president in 1970 after the death of President Gamal Abdel Nasser. Like Nasser, Sadat demanded the return of Egypt's Sinai Peninsula and Gaza Strip, which Israel had occupied after the Arab-Israeli War of 1967. During an Arab-Israeli war in 1973, the Egyptian army retook a small part of the Sinai Peninsula. After the war, Sadat's government reached agreements with Israel under which Israeli troops withdrew from more land that they had occupied on the Sinai. In 1977, Sadat and Israeli Prime Minister Menachem Begin started discussions of ways to end the Arab-Israeli conflict. In 1978, Sadat, Begin, and President Jimmy Carter held discussions in the United States at meetings arranged by Carter. The discussions resulted in a major agreement that included plans for Israel's withdrawal from all of the Sinai. It also provided for a five-year period of self-government for the Gaza Strip and the Israeli-occupied West Bank of Jordan, followed by a decision about their status. In addition, the agreement called for the creation of a peace treaty between Egypt and Israel. Sadat and Begin shared the 1978 Nobel Peace Prize for their efforts to end the Arab-Israeli conflict. The peace treaty was signed in 1979, and Israel completed its withdrawal from the Sinai in 1982. But no arrangements for self-government for the Gaza Strip and the West Bank were established at that time. See **Middle East** (Recent developments).

Sadat was born in a village in the Nile River Delta. He graduated from the Egyptian Military Academy in 1938. He then joined Nasser and other young military officers in a secret organization that worked to overthrow the government and rid Egypt of British influence. Sadat was imprisoned during the 1940's for his revolutionary activities. In 1952, he helped lead the revolt that overthrew King Faruk. Sadat held a series of important government positions after the uprising. He served as vice president of Egypt from 1964 to 1967 and from 1969 to 1970, when he succeeded Nasser as president.

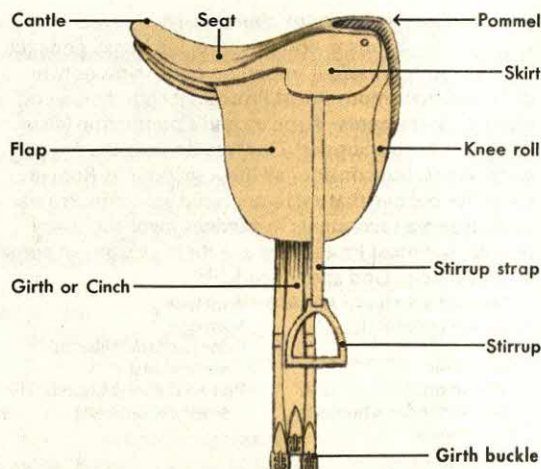
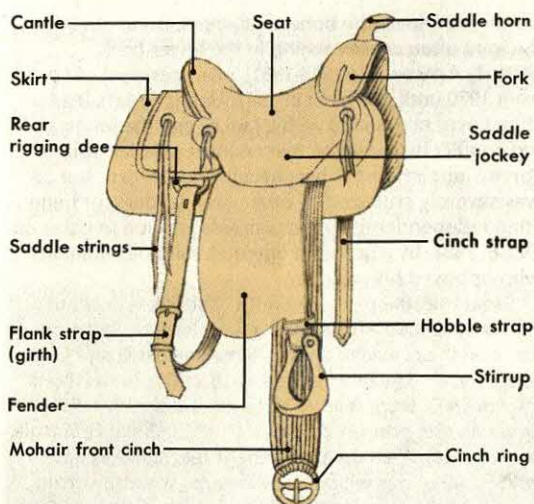
Saddam Hussein. See **Hussein, Saddam**.

Saddle is a seat used by a rider on a horse. There are many different kinds of saddles. They range from a mere blanket, such as American Indians used, to the saddles of feudal knights, which supported them on their horses when they were struck with a lance or spear.

The main parts of most saddles are a *seat*, usually made of leather; a *girth* (strap) underneath the horse, which may be tightened to secure the saddle; and *stirrups* for the rider's feet. There is usually a *panel* under the seat to protect the horse's back from irritation, and a leather *flap*, which hangs down on both sides of the horse to protect its sides.

Two forms of saddle are the *English* and the *Western*. The English saddle is almost flat, with only a slight curve

8 Sadducees



Saddles are designed for specific purposes, such as riding, racing, and working. The saddle on the left is of the type used by United States cowboys and rodeo riders. The saddle on the right is used by pleasure riders.

in the seat. The front of the seat comes to a slight point called the *pommel*, while the back is wider and slightly raised to form the *cantle*. The Western saddle has wide stirrups, a high cantle, and a pommel raised to make a *horn* to which a lariat may be fastened.

See also *Horse* (Riding equipment).

Sadducees were members of a religious group of Jews that was active in Judea, in Palestine, until A.D. 70. The Sadducees gained influence in Judea after Judea became a province of the Roman Empire in 63 B.C. They opposed a group of Jews called the Pharisees in religious beliefs and practices. Unlike the Pharisees, they accepted only the written law of the Hebrew Bible, and refused to recognize the Oral Law as binding upon them. In addition, the Sadducees did not believe in immortality, as the Pharisees did. They said that the soul died with the body. They also believed that all people had free will and were responsible for whatever good or evil befell them. See also *Pharisees*; *Sanhedrin*.

Sade, Marquis de (1740-1814), was a controversial French novelist and essayist. Today, some people regard Sade as having been insane and his works as offensive. Many other people consider him an often brilliant writer with a descriptive, eloquent style.

Donatien Alphonse François Sade was born in Paris. He served as a cavalry officer in the Seven Years' War (1756-1763). During his 20's, Sade began to show signs of being mentally disturbed. He became involved in many scandals over his acts of cruelty and his sexual behaviour. Sade spent most of the years from 1768 to 1803 in prison for his writings and his actions. He was placed in an asylum in 1803 and died there.

Sade produced many essays, plays, and short stories, as well as novels. His best-known novels include *Justine, or the Misfortunes of Virtue* (1791) and *Philosophy in the Bedroom* (1795). His *120 Days of Sodom* was not published until 1904.

In his writings, Sade tried to show that criminal acts and sexual abnormalities are natural to human behaviour. The word *sadism* comes from his name. Sadism is

the enjoyment of cruelty, especially—as in the case of Sade—for sexual satisfaction.

Sadi, an alternative spelling of Saadi. See *Saadi*.

Sadism. See *Sade, Marquis de*.

Sadler, Sir Michael (1861-1943), was a leading educationist who did much to reform the educational systems of England and India. He was a member of the Bryce Commission on secondary education in 1894 and 1895. From 1915 to 1922, he was chairman of the Teachers' Registration Council. Sadler was born at Barnsley, in South Yorkshire, England. He served as vice chancellor of Leeds University from 1911 to 1923.

Sadler's Wells is the name of a theatre in London. The theatre was the birthplace of an opera company and a major ballet troupe. In 1683, a man named Sadler found that the well on his property north of London had medicinal waters. He set up a public garden round it. It became famous as a spa where people could enjoy plays and music.

A theatre was opened there during the 1700's. It was rebuilt in 1931 and opened under the direction of Lilian Baylis (see *Baylis, Lilian Mary*). At first, she directed plays, operas, and ballets. But later, the theatre was devoted entirely to operas and ballets. Its ballet company became the Royal Ballet in 1957 and moved to the Royal Opera House, Covent Garden. The opera company moved to the Coliseum in 1968. In 1974, the company was renamed the English National Opera.

Sadowa, Battle of. See *Seven Weeks' War*.

S.A.E. rating. See *Horsepower*.

Safari is an organized hunt in Africa. Hunters join safaris for a chance to kill Cape buffaloes, elephants, leopards, lions, rhinoceroses, or other big game. An organized trip to photograph wild animals is also called a safari. Most safaris last from three to six weeks. Most of them are organized by a safari company that provides all the necessary supplies and personnel.

Many African countries limit the number and kind of animals that may be killed. Some countries also specify the weapons that may be used to kill certain animals.



Taking precautions helps prevent accidents. For example, keep stairways clear of objects, *left*. They might cause someone to trip. The worker at the top right wears protective clothing while handling chemical drums. Many schools teach safety education, *bottom right*.

Safety

Safety is freedom from harm or the danger of harm. The word *safety* also refers to the precautions people take to prevent accidents. Accidents are a leading cause of death throughout the world. In the United States, for example, about 94,000 people die every year as a result of accidents. About 9 million people are seriously injured. Accidents also cost vast sums of money annually in medical expenses and lost income.

Experts called *safety engineers* work in the field of accident prevention. They design structures and equipment to make homes, schools, jobs, roads, and communities safer.

Nevertheless, safety starts with you. Living safely does not mean a dull existence. You can live an active, accident-free life that is full of fun and achievement. But you must be aware of possible hazards and take sensible precautions. Most mishaps can be prevented by following basic safety rules.

Safety at home

Most people consider their home a safe place, but it may be the most dangerous place of all. About one-third

of all accidental injuries occur in the home. Household mishaps are a major cause of accidental death in many countries.

With planning, your home can be safe and comfortable. Nearly all accidents that occur in the home can be prevented by following basic safety rules in the kitchen, in the bathroom, in utility areas, and in the garden. In addition, you must take precautions for safety with electricity and for protection against fire.

In the kitchen. In many homes, the kitchen is the busiest room—and one of the most dangerous. Climbing and reaching cause many accidents in the kitchen. Never use a chair, table, or pile of boxes as a ladder. Use a real ladder, and have someone hold it for you if possible. Do not lean to the side while on the ladder. Careful storage reduces awkward climbing and reaching. For example, keep heavy objects, such as food mixers and roasting pans, on low shelves, and light items higher up.

To prevent cuts, keep kitchen knives in a knife rack, not loose in a drawer. Store sharp-edged tools in a rack or box. Sweep up broken glass as soon as possible, and never pick up glass splinters with your bare hands.

10 Safety

Sweep the splinters into a dustpan and use a damp paper towel to pick up any remaining particles.

Prevent falls by wiping up water, grease, or anything else spilled on the floor. If you use floor wax, buff the waxed surface thoroughly or use a nonskid product to make the floor less slippery.

Be careful not to burn or scald yourself or others while cooking. Turn saucepan handles toward the back of the stove. If a handle sticks out, a child might grab it or a passing adult might knock the saucepan over.

Many people use an oven cleaner and other potentially dangerous chemicals in the kitchen. These chemicals should be used according to the manufacturer's instructions and be kept in a locked cupboard.

In the bathroom. Falls are one of the worst dangers in the bathroom. To prevent them, use a rubber mat or adhesive-backed vinyl strips in the bath or shower. Also, install a sturdy handrail to the wall over the bath. Keep soap in a holder so you can reach it easily and to prevent it from falling underfoot. Use only nonskid bathroom rugs, and wipe up spilled lotions, other liquids, and powders to prevent slipping.

Medicine cabinets contain many dangerous items. For example, ordinary aspirin tablets are a common cause of poisoning among children. Use a medicine cabinet with a lock so that aspirin and other drugs can be kept away from youngsters. Never tell children that medicine tastes like sweets. Whenever you take medication, read the label carefully to be certain of the instructions. Never take medicines in the dark or take medicine prescribed for someone else. Throw out old medicines, but not where children might find them. In addition,

such cleaning products as bleaches and drain cleaners should be stored in a locked cabinet to keep them away from children.

Dry your hands thoroughly before using a hairdrier or any other electric appliance. Water is a good conductor of electricity, and you could be electrocuted by touching anything electrical while your hands or feet are wet. If you listen to a radio while taking a bath, use a battery-powered model. A plugged-in radio could electrocute you if the radio fell into the water or if you touched it with wet hands.

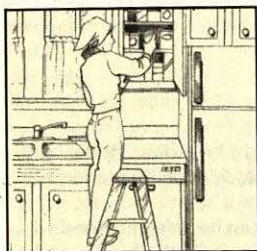
In utility areas. Safety in utility areas depends largely on the careful use of such dangerous items as power tools, appliances, and poisonous chemicals. The chemicals, which include cleaning products, paint thinners, and insecticides, should be kept in containers that have a childproof lid or cap. Store all hazardous items in a locked cabinet so that youngsters cannot get at them.

Do-it-yourself projects can be dangerous. Select your tools carefully, handle them with caution, and clean up thoroughly after you finish working. Dress properly when you work with power tools. For example, wear shoes instead of sandals. Tuck in your shirttail, and remove any ring, watch, or other jewellery that might get caught in the tool. Use safety glasses or a dust mask when sanding or grinding. Do not use power tools if you are tired or upset. Never leave a tool plugged in if children are present.

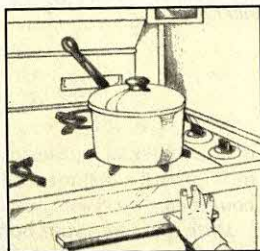
Dispose of an old freezer or refrigerator if it is not being used—or at least remove the door. A child might use the appliance as a hiding place, become trapped inside, and suffocate.

Safety at home

Accidents account for many injuries and deaths in the home. Almost all mishaps at home can be prevented by observing basic safety rules, such as those shown below.



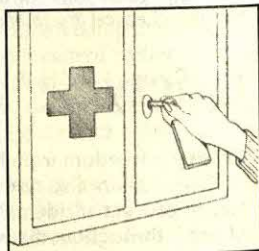
Use a ladder to reach high objects. Never climb on chairs, tables, or boxes.



Turn saucepan handles toward the back of the stove to avoid burns and scalds.



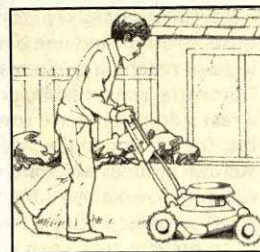
Install nonslip strips in the bath and provide handrails to prevent falls while bathing.



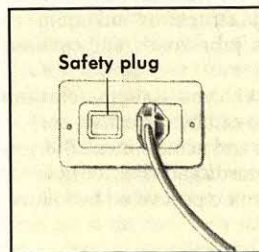
Keep medicine locked up, out of a child's reach. Never use unlabelled medicine.



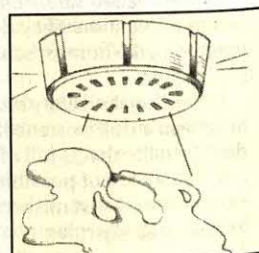
Wear safety equipment, such as protective glasses, when using tools.



Wear shoes when mowing the lawn. Keep away from the blades of the mower.



Attach a safety plug to any unused electric socket that can be reached by children.



Install a smoke detector to help ensure safety in case of fire.

In the garden. If you use a spade or shovel when gardening, wear heavy work shoes to prevent foot injuries. Use work gloves to protect your hands from cuts and scratches. Learn to recognize poisonous plants so you can stay away from them. If you use a fertilizer, pesticide, or weedkiller, avoid breathing the dust or spray and try not to get it on your skin.

When using a lawn mower, keep your feet away from the machine and never pull it toward yourself. The mower could run over your foot and gash it. Before mowing, remove stones, pieces of wire, and other small objects from the lawn. The blades of the mower can hurl such objects some distance. If you have a power mower, never clean the grass chute while the motor is running.

Keep your lawn and garden tools in a garage or shed. Never leave them lying around where someone might step on them and be hurt.

If you have a swimming pool, guard it with a fence and a locked gate. Make sure the pool is supervised whenever anyone uses it. People who use the pool should know such safety techniques as how to dive properly and how to use lifesaving equipment. Keep the pool drained during periods when it is not used.

Safety with electricity. Electric tools and appliances are conveniences throughout the home. But they must be used carefully. Careless use of electricity can kill you.

All tools and appliances that you buy should have the seal of approval from your country's safety organization. Such organizations test electric products and approve only those that meet their standards of safety.

Use electric products carefully and follow the manufacturer's instructions. Never operate a power tool in the rain or in a damp area.

Ensure that all appliances are connected to earth. This avoids electrocution if the appliance malfunctions or an accidental short between a live wire and metallic parts of the appliance occurs. Always replace fuses by new ones that correspond to the power rating of the appliance. For example, a short circuit in the windings of an electric motor rated at 1 ampere can still cause fire if it is fused with a 15 ampere fuse. Before replacing a fuse, try to find out what caused the fuse to burn out. Appliances of high power ratings, such as washing machines, should be fused individually (see Fuse).

The best protection against accidental electrocution are earth-leakage detectors. These devices disconnect an electric circuit if a current, such as a current caused by someone touching a live wire, flows between the live circuit and earth.

Never connect too many electric appliances to one connector or extension cord. Overloading a connector or wire can cause fire. Disconnect heating appliances and irons when leaving the house.

Pull the plug before you clean or repair an electric tool or appliance, and before changing the accessories of a power tool. Let a qualified repair service handle complicated repairs.

All electric sockets should be covered if any children in the home could reach them. Special plugs can be installed to cap unused sockets.

Safety from fire. Most of the deaths and injuries that are caused by fire occur at home. Some simple precautions can help keep your home—and the people in it—safe from fire.

Keep matches and flammable materials away from children. Never allow youngsters to play with fire. Check all electric wiring and replace any that seems worn or defective.

Clear out rubbish, old clothing, and other unused items from the attic, basement, cupboards, and other storage areas. A fire could easily start there.

Petrol and other flammable liquids, such as paint and furniture polish, should be stored in tightly covered containers. Keep such items away from the stove, fireplace, and other sources of heat. Put a screen in front of the fireplace to prevent sparks from flying out.

Cigarettes and other smoking materials must be put out completely, using ashtrays. Never allow anyone to smoke in bed.

You can help ensure your family's safety in case of fire by keeping fire extinguishers and by installing one or more smoke detectors. These devices sound an alarm at the first sign of smoke. Plan an escape route from each room and hold a home fire drill regularly. All exits must be kept clear at all times.

Other precautions must be taken in every room of your home. One of the most important safety defences is good housekeeping. Do not leave toys, shoes, and other objects on the floor where someone could trip over them. Tools and household cleaners should never be placed where children can get at them. For the greatest safety, keep everything in its proper place. After you have used an item, put it away immediately.

If you have firearms in your home, keep them unloaded and lock them in a rack or cabinet. Ammunition should be locked in a separate place.

Good lighting is important throughout the home, but it is especially vital in hallways and other heavily travelled areas. Night lights can help promote safety in bedrooms and bathrooms.

The burning of oil, petrol, and certain other fuels may produce deadly carbon monoxide gas. To guard against carbon monoxide poisoning, never leave a car engine running in a closed garage. Fuel-burning stoves, heaters, and other appliances should be used only in well-ventilated areas.

Safety at school

School officials try to make their institution as safe as possible. They conduct safety training programmes for students and teachers and hold regular fire drills. Schools are usually required to provide clearly marked exits, fire escapes, and first-aid equipment.

However, accident prevention remains the responsibility of each student and teacher. Everyone must work together to make a school free of hazards.

In corridors and on stairways, many accidents occur because students are rushing to get to the next class or to go home. You can lessen the danger of an accident by walking, instead of running, in corridors. Do not crowd or shove. Never throw paper or other objects on the floor where someone might slip on them and fall. On stairways, never take two or more steps at a time. Use each step and, if necessary, hold the handrail to steady yourself.

In classrooms, keep your feet out of the aisles. Do not leave scissors or other pointed tools on chairs or desks where they could injure someone. Do not throw



At school, safety rules help prevent accidents on stairways. Never run or shove on stairs, *left*. Keep to one side, take one step at a time, and use the handrail to steady yourself, *right*.

such items as pencils, pens, or paper clips at other students. Thrown objects can cause serious eye injuries. Do not push or crowd when entering or leaving a classroom. Help prevent accidents by reporting broken chairs, desks, and other equipment.

In gymnasiums and on athletic fields. More accidents occur in sports than in any other school activity. Teachers and coaches want to protect you, and you should follow their instructions and advice. Warm up to loosen your muscles before taking part in any physical activity. Learn how to fall safely. Try not to lose your temper during sports. Your anger could result in an injury to another player—or to yourself.

Each sport involves different safety precautions. If you play cricket, be sure to wear proper protective equipment. Baseball players must try to avoid collisions with other players, being hit by a bat or ball, and being spiked while sliding. In basketball, the chief hazards include collisions between players; twisted ankles; and running into walls, seats, or other structures.

In other school areas. Safety precautions are essential in science laboratories. Each lab should be equipped with one of two types of fire extinguishers—liquefied gas or dry chemical. Such fire extinguishers, unlike those filled with water, can be used on oil, grease, or electric appliances that catch fire. Every laboratory should also have first-aid equipment, a safety shower, and a spray for rinsing the eyes or face. When working on certain projects, students should wear a lab apron and an eye or face shield.

The art room needs good ventilation to remove the dust involved in making ceramics and the toxic vapours produced by silk-screen printing. Ceramics students also should wear dust masks.

The woodshop has many dangerous tools that must be stored carefully so they will not fall and cause injuries. All power saws must have a guard so that the user's hands cannot touch the blade. Students should wear safety glasses. Floors must be kept as free as possible of sawdust, grease, and scraps or chips of any material.

Safety in recreation

When people are having fun, they may not think about safety. Many are injured or even killed because

they did not take precautions during recreational activities. In all such activities, know the limits of your strength and skill and do not try to exceed them. Never take chances. Be considerate of others. Wear the proper clothing for each activity, and use only equipment that is in perfect condition.

In winter sports, people must protect themselves against the cold in addition to taking the precautions involved with most other sports. A special hazard is a condition called *hypothermia*, in which the body temperature falls below its normal level of 37° C. The symptoms of hypothermia include uncontrollable shivering, slurred speech, stumbling, and drowsiness. If left untreated, the condition may lead to death. Hypothermia can occur even if the temperature is above freezing, especially if a person's clothing is wet.

To help prevent hypothermia, wear wool clothing. Wool provides better insulation than other fabrics do. Wear loose garments that do not restrict the circulation of the blood. Several layers of light clothing are better than one heavy layer. Cover your head, hands, and feet because they lose heat quickly.

Snowmobiling is increasingly popular in many northern climates and has led to a large number of accidents. Speeding causes many snowmobile mishaps. Never go faster than the safe speed for your vehicle, and never drive too fast for the snow conditions. A snowmobile should not be operated in less than 100 millimetres of snow. If possible, drive only in daylight. About three-fourths of the fatal snowmobile accidents occur after dark. Be especially careful when crossing roads and watch for such obstacles as tree stumps, fallen logs, and hidden branches.

Skiing causes thousands of broken bones, sprains, and other injuries every year. To help prevent skiing accidents, use the proper ski equipment, including well-fitted boots, and keep your equipment in good shape. If you are a beginner, be sure to get expert instruction. Go on difficult slopes only if you are an experienced skier in good physical condition. Stay with other people when skiing. If you are injured while alone, it may be difficult for someone to find you.

Tobogganing. Examine your toboggan and repair any broken parts or split wood. Sharp edges should also be eliminated before you go tobogganing.

Choose your area carefully. Do not toboggan on streets, where you might slide into the path of a car. Steep hills are dangerous because you might go too fast and be unable to stop. Do not go tobogganing on frozen ponds or lakes where the ice could break under your weight. The ideal area for tobogganing is a broad, gently sloping hillside that is free of trees and not crossed by any road.

Ice skating. Many thousands of people a year suffer injuries while ice skating. Skaters may trip on bumps in the ice, collide with other skaters, or fall through thin ice. Beginners need expert instruction, and all skaters should keep their skates in good condition.

In water sports. Drowning is a leading cause of accidental death in many countries. Only traffic mishaps and falls cause more accidental fatalities. In the United States, for example, about 5,000 people drown yearly, many while they are swimming or boating. In the United Kingdom, about 550 people drown yearly.

Swimming. Never swim alone. You might get a cramp or be injured, and you could drown before anyone realizes you are missing. If a beach has lifeguards, swim only in areas protected by the lifeguards. If you are a weak swimmer, stay in shallow water and use an inner tube, water wings, or other device to help stay afloat. Do not swim when you are chilled, overheated, or tired. Stay out of the water during thunderstorms and other severe weather. Children must be watched closely when in or near the water.

Never attempt a rescue unless you are a trained lifeguard. Many drowning people struggle and pull their would-be rescuers down with them. However, you might be able to help a swimmer in distress without entering the water. If you are near enough, extend a fishing pole or similar object and pull the swimmer to safety. Keep your body low to avoid being pulled into the water. If the person is too far to reach, throw a life belt or anything else that will help the swimmer float.

Boating. The chief causes of boating accidents include speeding, poor judgment, and recklessness. Boaters should know the safety limitations of their craft and never exceed the safe speed or the maximum number of occupants. Usually, regulations cover such matters as the use of warning lights and the right of way when boats approach each other.

Safety at work

Workers suffer a variety of disabling injuries annually while at work. Job mishaps result in many lost workdays and cost vast sums.

The careful use of tools, including scissors, knives, hammers, and screwdrivers, is important for all employees, regardless of where they work. Use the right tool for the job, and use it correctly. Keep tools in good condition, and store them in a safe place. You should also lift heavy objects properly to avoid sprains and strains. Bend your knees to grasp the object, hold it close to your body, and use your leg muscles rather than your back to lift the load. Safety experts recommend special steps to reduce the number and cost of injuries in factories and offices.

In factories. Employers in many countries protect their workers with a wide range of safety devices and regulations. For example, some machines have guards over their moving parts. Many factories also have sprinkler systems or other devices to control fire, barriers to prevent falls, and equipment to get rid of dust and fumes. Many workers in factories are required to wear protective equipment, including goggles, ear protectors, safety helmets, fire-resistant clothing, and steel-toed shoes.

Professional safety engineers work to control or eliminate hazards in many factories. They perform regular safety inspections and recommend steps to remove any dangers they find. Safety engineers also conduct safety-training classes for employees. In factories that do not have a full-time safety engineer, committees made up of workers and managers perform safety inspections.

Workers in factories must share the responsibility for safety. They should inspect their workplace and report any hazards that might cause an accident. Employees also should operate machinery correctly and never smoke in no-smoking areas.

In offices, the level of safety is higher than in factories. Nevertheless, office workers must obey basic safety rules. For example, they should walk, not run, on stairways and must operate machines and other equipment correctly. Fire safety is especially important in high-rise buildings. Many companies hold fire drills to help employees become familiar with emergency exits and the procedures to follow in case of danger.

In some countries, office staff receive instruction in *cardiopulmonary resuscitation* (CPR), an emergency procedure performed on victims of a heart attack. This technique can keep a person alive until medical help arrives.

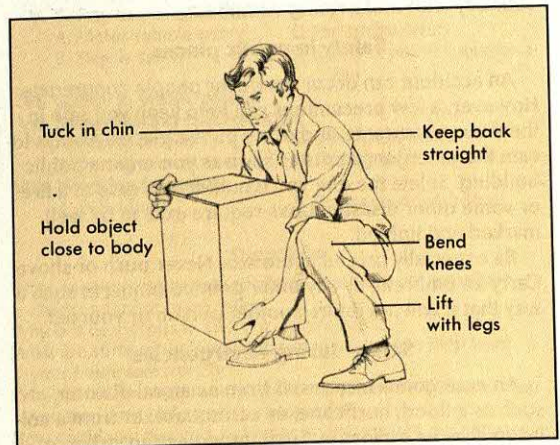
Safety in transportation

Motor vehicle safety. Accidents involving motor vehicles are the leading cause of accidental death in many parts of the world. In the United Kingdom, for example, about 2,300 people died in car accidents in 1989.

Safety engineers work to improve vehicle construction, road design, and traffic signs. But each individual



Recreational activities require certain safety precautions. When tobogganing, *left*, dress warmly and use a gently sloping hill. Always stay near a companion when swimming, *right*.



Safe lifting is an important part of job safety. Many people suffer injuries by lifting a heavy load improperly. The illustration above shows the proper way to lift a heavy object.

14 Safety

motorist has the chief responsibility for safety. Most traffic accidents result from careless driving.

You can increase your safety by following common-sense rules. Fasten seat belts—or children's car seats—to help prevent injuries and save lives. Obey the speed limit. Treat other drivers courteously. Signal when you plan to turn or change lanes, and stay a safe distance from other vehicles. Keep your car in good running condition. Never drive under the influence of alcohol or medicines, or if you are tired or upset.

Motorcyclists should wear safety helmets and obey the same traffic rules followed by car drivers. They also should drive at speeds that are safe for their motorcycles and for road conditions.

Bicycle safety. Only one person at a time should ride on a bicycle built for a single rider, and stunts should never be attempted while biking. Obey traffic signs and signals. Ride in the same direction as other traffic and never hitch a ride by holding on to a motor vehicle. Always signal before you turn a corner or stop. Equip your bike with reflectors and lights if you ride at night.

Pedestrian safety. Motor vehicles kill thousands of pedestrians a year. Many victims are hit while crossing streets. Large numbers of them had been drinking before being struck.

You can help avoid injury or death by crossing streets only at road junctions. Obey traffic lights and look both ways before you cross in case a car is coming. Walk on the pavement or sidewalk rather than in the street.

Children should never play in the street. They also can protect themselves from being hit by stopping and looking in both directions before chasing a ball or anything else into the street.

Safety in public transportation. People are much safer when using public transportation than when riding in private vehicles. The operators and crews of buses, trains, aeroplanes, and other vehicles used in public transportation are trained to protect the safety of their passengers. As a result, the accident rate for public vehicles is normally low.

Passengers can help lower the accident rate even further by not distracting the operator of the vehicle with conversation. Passengers also should practise common courtesy with those riding with them.

Safety in public places

An accident can occur wherever people congregate. However, a few precautions can help keep you safe in theatres, restaurants, and other public places. Always locate the emergency exits as soon as you enter a public building. Select the one you would use in case of a fire or some other disaster. Laws require exits to be well marked and lighted.

Be especially careful in crowds. Never push or shove. Carry an umbrella or any other pointed object in such a way that it will not injure another person or yourself.

Safety during emergencies

An emergency may result from a natural disaster, such as a flood, hurricane, or earthquake; or from a collision, fire, or explosion. Such tragedies can strike so suddenly that it is difficult to be prepared for them. However, you can lessen the risks if you know what to do during a flood, hurricane, tornado, or earthquake.

During a flood. Leave the flood area as soon as a flood warning is announced. Do not be caught in a low-lying place. Take food and clothing with you.

When you return after the flood, have all electric lights and appliances checked before using them. Boil all drinking water until health officials announce that the water supply is safe. If your car was submerged, have a mechanic check it for water in the brakes, power steering, and elsewhere.

During a hurricane. Keep your radio tuned to a news station after learning that a hurricane warning has been broadcast. Board up your windows or protect them with special storm shutters or tape. If you have a boat, anchor it securely or take it to a safe place. Store drinking water in clean bottles and jugs, and fill the bathtub with water for later use. Make sure the petrol tank of your car is full because service stations may not be able to operate for several days after a hurricane. But do not store cans of petrol in your car or home.

Stay home if the structure is sturdy and on high ground. Otherwise, move quickly to a designated hurricane shelter. Stay home or in the shelter until an all clear has been given. After the storm, avoid loose or dangling electric power lines and report them immediately to the power company.

During a tornado. If your area lies in the path of an approaching tornado, seek shelter in an underground structure, such as a basement, underground station, or parking garage. Stay out of the upper storeys of buildings and away from windows. If you are in a building that has no basement, go to the lowest floor and lie flat. Cover yourself with a rug or blanket for protection against flying glass and rubble.



A child's car seat, above, helps protect the youngster from injury in car accidents. Motor vehicle accidents are the leading cause of accidental deaths in many countries.

If possible, open some windows and doors on the side of the building away from the approaching tornado. A tornado sucks up air when passing over a building, and the air pressure outside may drop so suddenly that the structure explodes outward. Opening windows and doors helps equalize the pressure.

If you are in a car or other vehicle, try to escape by driving at a right angle to the path of the tornado. If you cannot reach shelter or escape, lie in a ditch or other hollow place.

During an earthquake. If you are indoors when an earthquake occurs, take cover under a table or desk. Stay away from windows. If you are outside, move away from buildings, where you might be struck by falling bricks and other rubble. If you are in a car, stop immediately but stay in the vehicle.

Working for safety

Safety is everyone's responsibility. Individuals, business and industry, government agencies, and private organizations share the obligation to protect people from needless injury and death.

Individuals have many safety responsibilities. For example, you should follow the manufacturer's instructions on all products. Purchase the proper tool or appliance for the work to be done, and never use a device beyond its limitations. Report any unsafe conditions in the community to the proper officials. Provide safety instructions to children. Drive safely.

Business and industry have responsibilities for the safety of customers and employees. They have an obligation to manufacture products that are safe to use, and they must give consumers complete instructions that will prevent accidents.

Employers also have the duty to provide safe working conditions and safety education programmes for employees, and to hold frequent fire drills. In addition, they must furnish safety equipment and have enough exits for use in an emergency.

Related articles in *World Book* include:

Safety at home

Botulism	Fire prevention
Drug (table: Rules for using drugs)	Match (Matches can be dangerous)
Fire brigade (Fire prevention and fire safety)	

Safety in recreation

Boating (Boating safety)	Drowning
Camping (Camping safety and courtesy)	Ice skating (Skating safety)
Diving, Underwater (Dangers of underwater diving)	Sunburn
	Swimming (Water safety)

Safety at work

Business (Health and safety regulations)	Dust explosion
Coal (Mine safety)	Radiation (Protection against radiation)

Safety in transportation

Airport (Air traffic control)	Car (Driving safely)
Bicycle (Bicycle care and safety)	Ship (Safety at sea)

Safety during emergencies

Lightning (Protection from lightning)	Tornado (Protection against tornadoes)
---------------------------------------	--



Safety on farms is particularly important, especially where children may stray into machinery.

Safety devices

Fire extinguisher	Lightning rod	Safety valve
Life jacket	Safety lamp	Smoke detector

Other related articles

Consumerism (The right to safety)	Poisonous plant
Eye (Preventing eye damage)	Woodworking (Tool care and safety)
Mushroom (Poisonous mushrooms)	

Outline

I. Safety at home

- A. In the kitchen
- B. In the bathroom
- C. In utility areas
- D. In the garden

II. Safety at school

- A. In corridors and on stairways
- B. In classrooms

III. Safety in recreation

- A. In winter sports

IV. Safety at work

- A. In factories

V. Safety in transportation

- A. Motor vehicle safety
- B. Bicycle safety

VI. Safety in public places

VII. Safety during emergencies

- A. During a flood
- B. During a hurricane
- C. During a tornado
- D. During an earthquake

VIII. Working for safety

- A. Individuals
- B. Business and industry

Questions

What common household products should be stored where children cannot reach them?
 Why is it dangerous to swim or ski alone?
 What are some of the precautions you can take to help keep your home safe from fire?
 Why should you open some doors and windows if the building you are in may be struck by a tornado?
 How could you rescue a swimmer in distress without entering the water yourself?
 What is *hypothermia*? How can it be prevented?
 Where should you seek shelter during an earthquake?
 What rules govern the safe use of electric products?

16 Safety lamp

Safety lamp is a lamp designed to warn coal miners of the presence of firedamp, a gas that can cause destructive mine explosions. Firedamp is composed chiefly of methane and air. Coal-mining operations can release the gas, which forms when plants decay during the coal-forming process.

The safety lamp burns oil. Inside the lamp a wire gauze cylinder of fine mesh forms a cage around the flame. Firedamp can be detected by lowering the wick on the lamp. If firedamp is present, a pale blue flame appears around the central flame. This warns a miner to leave the spot immediately.

The heat of the flame will not pass beyond the gauze covering and light the gas on the outside until the wire becomes as hot as the flame. The wire around the miner's safety lamp has good conducting power and will not heat up before the miner has time to escape. Most safety lamps are locked in order to prevent miners from opening them. Some lamps go out when they are opened. Firedamp detectors based on electricity and light have been invented. However, the safety lamp is still widely used by miners.

The safety lamp is based on a principle discovered by the English chemist Sir Humphry Davy. He made the first successful safety lamp in 1815.

See also **Damp; Davy, Sir Humphry.**

Safety pin. See **Pin.**

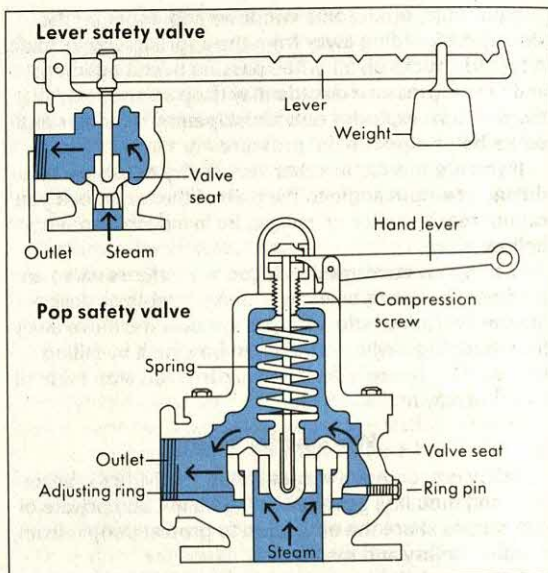
Safety valve is attached to a steam boiler to release some of the steam if the pressure becomes higher than the boiler can safely stand. It consists of a cone-shaped vent into which a plug is fitted. This plug is held in place by a lever bearing a weight. The maximum steam pressure in the boiler can be increased or decreased by shifting the weight on the lever. Many safety valves use a spring instead of a weight. This is because a spring is less subject to accident. Spring safety valves are called **pop** safety valves. The tension of the spring can be regulated so that the valve will "pop" at any desired pressure. Hot water heaters also have safety valves. See also **Bismuth.**

Safflower is a plant grown chiefly for the oil obtained from its seeds. The oil is used in cooking and processing foods, and in making paints and varnishes.

Safflower plants are cultivated in warm, dry regions, including Australia, India, Mexico, Spain, and the Southwestern United States. The plants grow from 0.5 to 1.5 metres high and have thistlelike flowers. Most varieties of safflowers have yellow or orange flowers, but some kinds have red or white flowers. The broad leaves are



A miner's safety lamp detects the presence of firedamp but will not ignite the gas that may surround it.



usually spiny. Safflower seeds are white and shaped like sunflower seeds.

Manufacturers use special machines to extract safflower oil from the seeds. Most manufacturers refine, bleach, and deodorize the oil after extraction. The oil has a light colour and a mild flavour. Its high levels of polyunsaturated fat and low levels of saturated fat make it valuable as a salad oil and a cooking oil. It also is used in making margarine, mayonnaise, and shortening. Many varnishes and paints contain safflower oil as a drying agent. The oil combines rapidly with oxygen in the air to form a tough coating for the paint or varnish.

Scientific classification. Safflower plants belong to the composite family, Compositae (Asteraceae). They are *Carthamus tinctorius*.



The safflower has large blossoms and thistlelike leaves and stems. Safflower seeds are used in making nutritious oil and meal.



Saffron is a food flavouring and dye, obtained mainly from the stigmas and styles of the purple autumn crocus. It takes 100,000 flowers to produce one kilogram of saffron. Saffron is used in food dishes such as the Spanish paella, and it is grown in large quantities in Spain.

Saffron is a brilliant yellow dye and a food flavouring. It is produced by drying the *stigmas* and part of the *styles* of the purple autumn crocus known scientifically as *Crocus sativus* (see **Crocus**). (Stigmas and styles are seed-bearing parts of a flower.) About 4,000 flowers yield about 28 grams of commercial saffron. Saffron has a sweet odour, but tastes bitter. It is used in cooking and in flavouring and colouring sweets. People in Europe and India use it to season various foods.

Saga is the name given to a large body of literature written in Iceland between the 1100's and the 1300's. The word *saga* is related to the Icelandic verb meaning "to say" or "to tell."

There are many kinds of sagas. The earliest sagas were biographies of Icelandic bishops and Norwegian kings. The greatest achievement in this early historical writing was a complete history of the Norwegian kings composed by Snorri Sturluson in the 1200's.

The classic sagas were composed in the 1200's. These sagas are usually known in English as *Icelandic Family Sagas* and in Icelandic as *Sagas of Icelanders*. They are anonymous and vary in length from brief stories to the equivalent of full-length novels. Scholars once believed these sagas were transmitted orally from generation to generation until scribes wrote them down in the 1200's. But most scholars believe the sagas were conscious artistic creations, based on oral and written tradition.

The sagas were composed during a period of civil war and social decline. They glorified the moral and social codes of a "golden age" that occurred between 850 and 1050 during the early settlement of Iceland. They are tales of legal disputes and blood vengeance, and provide a picture of social and cultural conditions at that time. The longest and finest of the classic sagas is *Njal's Saga*, a tale of honour, death, and vengeance.

During the 1200's, the European literature of chivalry began to influence Icelandic writers. Sagas became more romantic and fantastic. By the early 1300's, the nature of sagas had completely changed. These later sagas described the adventures of many traditional Germanic heroes such as Sigurd the Dragon Slayer and Rollo. Generally, critics consider these sagas inferior to the earlier ones.

See also Snorri Sturluson; Sigurd.

Sagan, Carl Edward (1934-), is an American astronomer, author, and educator. He has gained fame as a leading popularizer of science. Sagan has written several books, numerous magazine articles, and many scientific papers. He was the chief writer and narrator of "Cosmos," a popular television series. The series dealt with a wide variety of scientific issues.

Sagan's writings reflect his broad interests. In his works, he discusses the nature of the planets and their atmospheres, the origin and evolution of life on the earth, and the possibility of life on other planets. One of his best-known books, *The Dragons of Eden* (1977), deals with the evolution of the human brain. The book received the 1978 Pulitzer Prize for general nonfiction. Sagan's other works include *Atmospheres of Mars and Venus* (1961), *Planetary Exploration* (1970), *The Cosmic Connection* (1973), *Broca's Brain* (1979), *Cosmos* (1980), which is based on the television series, and *Contact* (1985), a novel.

Sagan was born in New York City. He received a Ph.D. degree from the University of Chicago in 1960. In 1968, he became a professor of astronomy and space science at Cornell University.

Sage is the name of more than 750 species of herbs and shrubs. The *common sage*, also called *garden sage*, is known for its strong odour and bitter-tasting leaves and stems. It is an important herb for cooking.



Carl Sagan



Sage

18 Sagebrush

The common sage has white, woolly stems that grow to 60 centimetres tall. The greyish-green leaves have a rough, pebbled texture. The flowers grow in circular clusters at the tips of the stems and may be violet-blue, pink, or white. The common sage grows wild in the Mediterranean region. People also grow this plant in their gardens.

Cooks use the leaves and stems of the common sage in making seasonings for sausages and cheeses, dressings for meat, and sauces. The plant also is brewed to make tea. The *white sage* has blossoms rich in nectar that bees use to make honey (see **Honey**).

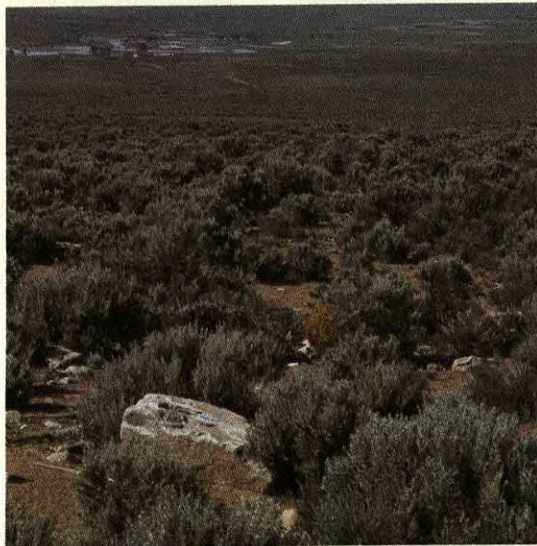
Scientific classification. Sage belongs to the mint family, Labiatae (Lamiaceae). Common sage is *Salvia officinalis*. White sage is *S. apiana*.

Sagebrush is a shrub known for its sweet smell and bitter taste. It grows on the dry plains of the Western part of the United States. The plant may grow to any height from 0.5 to 4 metres, and has a straight stiff stem. The leaves are small and grow close together. The flowers grow at the top of the stem, and may be yellow or white. Each flower is made up of many tiny flowers called *florets*.

Sagebrush flourishes in the dry soil of the Western plains, where many other plants cannot grow. But it also grows on mountain slopes. Sometimes the heat and dryness in the summer dry up the plant so much that it shows no sign of being alive. Then, the wind often uproots the plant and blows it all over the plains, much as the wind blows tumbleweed. Sagebrush seeds are scattered in this way. Often sagebrush is the only plant life for great distances.

Sagebrush is not true sage, a plant used widely for seasoning (see **Sage**). Sagebrush received its common name from the sweet, sagelike odour of its crushed foliage. There are several types of sagebrush.

Scientific classification. Sagebrush belongs to the composite family, Compositae (Asteraceae). The common sagebrush is *Artemisia tridentata*.



Sagebrush flourishes in dry regions.



Sagittarius is a group of stars that form the ninth sign of the zodiac. This illustration is from *Uranographia* by Johann E. Bode, published in 1801.

Sagittarius, the Archer, is a group of stars that lies in the Southern Hemisphere of the sky. It is the ninth sign of the zodiac. In mythology, Sagittarius represents the mythological creature known as a *centaur* (half man and half horse). The centaur was supposed to hold a bow aimed at the heart of Scorpio, the neighbouring *constellation* (star group). Sagittarius has no brilliant individual stars, but contains spectacular star-clouds which mark the direction of the centre of our galaxy. Part of the constellation lies in the Milky Way, with a rich span of celestial objects. Sagittarius includes more objects than any other constellation listed in the first catalogue of *non-stellar objects* (nonstars) prepared by Charles Messier. The sun passes through Sagittarius from mid-December to mid-January.

See also **Astrology**; **Astronomy**; **Messier, Charles**; **Zodiac**.

Sago is a starch found in the spongy centre, or pith, of various tropical palm trees. A type of flour, called *sago flour*, is made from sago. The largest supply of sago comes from the East Indies. Large quantities of sago are sent to Europe and North America for commercial cooking purposes. Sago flour is used mostly in making puddings and as a thickening for soups. The flour is nourishing and easy to digest. Sago is one of the principal foods of East Indian people.

The fruit of the palm trees from which sago is produced is not allowed to ripen fully. The full ripening completes the life cycle of the tree and exhausts the starch centre. It leaves the trunk a hollow shell and causes the tree to die. The palms are cut down when they are about 15 years old, just before they are ready to flower. The stems, which grow 9 metres high, are split. The starch pith is taken from the stems and ground to a powder. A single palm yields about 360 kilograms of starch. The powder is kneaded in water over a cloth or sieve. It passes into a trough where it settles. After a few

washings, the flour is ready to be used in cooking. Sago is further refined and prepared for export.

See also **Arrowroot; Cornflour; Tapioca.**

Saguaro is the largest cactus of North America. This huge plant, often called the *giant cactus*, may stand as tall as 18 metres and weigh as much as 9 metric tons. The saguaro grows only in the foothills and deserts of southern Arizona, southeastern California, and northwestern Mexico. It is the state flower of Arizona.

The saguaro has a columnlike trunk that measures from 30 to 75 centimetres in diameter. The plant also has a few large, upturned branches. Grooves and *ribs* (ridges) run lengthwise along both the trunk and branches. Little rain falls in the region where the saguaro grows. The plant soaks up and stores large amounts of water after the rare showers that do occur. The grooves and ribs of the saguaro expand and contract, much like an accordion, depending on the amount of stored water.

Padlike structures called *areoles* grow along the ribs. Each areole has from 15 to 25 long spines. The branches



Saguaros store water in their trunks and branches.

of the saguaro grow from certain areoles on the trunk. During May and June, the areoles near the tip of the trunk and branches produce waxy, greenish-white flowers. These funnel-shaped flowers measure 7.5 to 10 centimetres long and bloom at night.

Bats, birds, and insects gather nectar from saguaro blossoms and, during the process, spread pollen from flower to flower. The pollinated flowers may then produce purplish-red, egg-shaped fruit. The mature fruit splits open, exposing watermelon-red pulp filled with black seeds. Many desert creatures eat the ripe fruit. The Indians of the region also eat the raw fruit or use it to make preserves and syrups.

Scientific classification. The saguaro belongs to the cactus family, Cactaceae. Many botanists classify it as *Cereus giganteus*. Others classify it as *Carnegiea gigantea*.

Sahara is the world's largest desert. It covers about 9 million square kilometres. The landscape of this vast African desert includes mountain ranges, rocky plateaus, gravelly plains, and sandy wastes. The barren desert is broken only by the cultivated land along the Nile River and in the scattered oases.

The Sahara extends more than 5,630 kilometres across northern Africa from the Atlantic Ocean to the Red Sea. It stretches more than 1,930 kilometres from north to south. The desert spreads over all of Western Sahara and almost all of Egypt. The Sahara also covers parts of Morocco, Algeria, Tunisia, Libya, Sudan, Chad, Niger, Mali, and Mauritania.

The word *Sahara* comes from the Arabic word *sahra*, meaning *desert*. Parts of the Sahara have separate names, such as the Libyan Desert and the Arabian Desert.

Land and climate. Mountains and uplands cover the central portion of the Sahara. The Ahaggar Mountains in Algeria rise 2,918 metres high. The uplands of a region called the Tassili-n-Ajjer lie northeast of those mountains. The Tibesti Mountains in Chad reach a height of 3,415 metres.

Scattered areas of barren, rocky plateaus and of gravelly plains make up most of the Sahara. The rest of the desert consists of vast seas of sand called *ergs*, which lie within large basins. In some places, the shifting sands of the ergs form dunes as high as 180 metres.

Oases lie throughout the Sahara. The water in these fertile areas comes mainly from wells or springs. The Sahara has about 90 large oases, where people live in villages and grow crops. In addition, there are many small oases, some of which can support only one or two families.

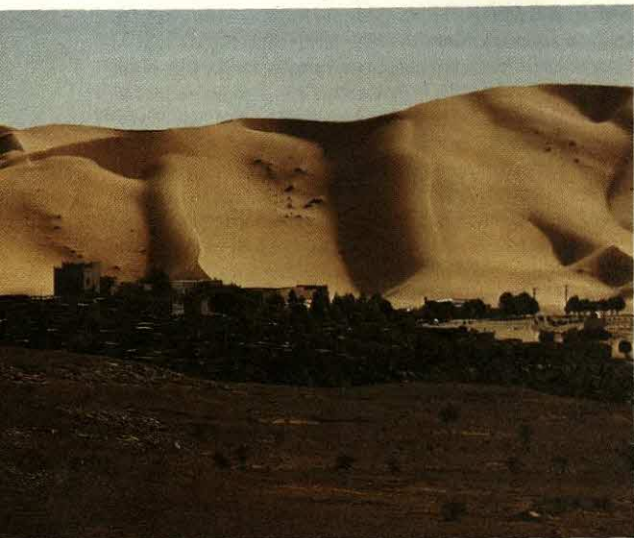
Major deposits of oil and natural gas lie under the Sahara in Algeria and Libya. These countries rank among the largest producers of the two vital fuels. The Sahara also contains valuable deposits of copper, iron ore, phosphates, uranium, and other minerals, but many of them have not been mined.

The Sahara has a dry, hot climate. The annual rainfall averages less than 20 centimetres. Large areas of the eastern and western Sahara receive less than 2.5 centimetres of rain yearly. The mountainous region of the central Sahara gets slightly more rain than other areas of the desert. Snow sometimes covers the mountain peaks.

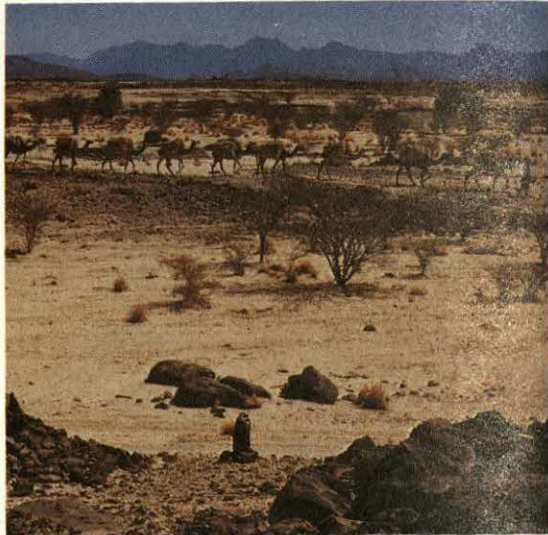
The Sahara is extremely hot during the day, but it turns cool at night. Summer temperatures often average above 32° C, and parts of the desert have daytime temperatures higher than 43° C. The highest official temperature in the world—58° C—was recorded at Al Aziziyah, Libya, in September 1922. Winter temperatures in the Sahara average from 10° to 16° C.

People. The Sahara has a population of less than 2 million. Large areas of the desert, such as the Great Western Erg and the pebbly plains of the Tanzerouft in Algeria, have no permanent settlements.

Most Saharan people are Arabs or Berbers or have mixed Arab and Berber ancestry. Some Negroid people also live in the desert. The chief inhabitants of the Sahara include the *Moors*, the *Tuareg*, and the *Toubou*. The Moors have mixed Arab and Berber ancestry and live in the northwestern Sahara. The Tuareg, a Berber-speaking group, occupy the central mountains and up-



An oasis village of the Sahara lies at the foot of a huge sand dune. Such oases as this one in Algeria are scattered throughout the dry areas of the vast desert.



A camel caravan in the Sahara, led by nomads of a Berber-speaking group called the Tuareg, crosses the desert in Niger. The Aïr, a mountainous region, rises in the background.

lands. The Toubou are a Negroid people of mixed ancestry who live in the Tibesti Mountains.

Most of the Saharan people are nomads who tend herds of sheep, goats, camels, and cattle. They travel through the desert in search of water and grazing land. Some tribes of nomads own land on the oases, but other people farm the land for them.

Most of the settlements on the oases have fewer than 2,000 people. The people grow dates, barley, wheat, and other crops. Some oases have thousands of date palm trees. But in areas that lack enough water, a single tree may be shared by several owners.

The Saharan people mainly use camels for transportation in the desert. In some areas, paved roads connect the principal oases. Motor vehicles can be driven across the desert along unpaved routes, but the crossing is difficult. Commercial airlines also provide transportation across the Sahara.

Plant and animal life is not as plentiful in the Sahara as it is in some other deserts. The grasses, shrubs, and trees that grow in parts of the Sahara have adapted to the dry conditions there. Some of the plants are *ephemeral* (short-lived). Their seeds lie in the ground and do not start to grow until rain falls. Then the plants grow rapidly and may complete their life cycle in six to eight weeks. Plants of the Sahara that live longer than a year obtain water in various ways. Some have long roots that reach deep into the soil and absorb moisture. Others take in moisture from the air through their leaves.

White gazelles and rare antelope called *addax* roam the sand dunes of the Sahara. Snakes, lizards, gerbils, and small foxes called *fennecs* also live in the dunes. Barbary sheep make their homes in the rocky plateaus. Most desert animals can go for long periods without water to drink. They get some water from the plants that they eat. Many of the small animals stay in their burrows during the day to avoid the heat. They come out at night to search for food. See *Addax*; *Fennec*; *Gazelle*; *Gerbil*.

History. During the Pleistocene Ice Age, which ended about 10,000 years ago, the region that is now the Sahara had a much wetter climate. It included a number of lakes and streams. Elephants, giraffes, and other animals roamed the grasslands and forests that covered much of the region at that time. Until about 5000 B.C., the region was inhabited by Negroid people who lived by fishing and hunting. Later, the skills of farming and rearing animals were introduced into the Sahara from the Middle East. Farming also developed separately in a southern area of the Sahara in what is now Mali.

About 4000 B.C., the African climate became drier and the Sahara region began to turn into a desert. Ever since then, the Sahara has slowly expanded. Through the centuries, people have contributed to the spread of the desert by overgrazing the land and cutting down trees and shrubs along the borders of the region.

As the Sahara became drier, the Negroid people moved south of the region. The Berbers, who lived along the northwest coast of Africa, gradually became established throughout the Sahara.

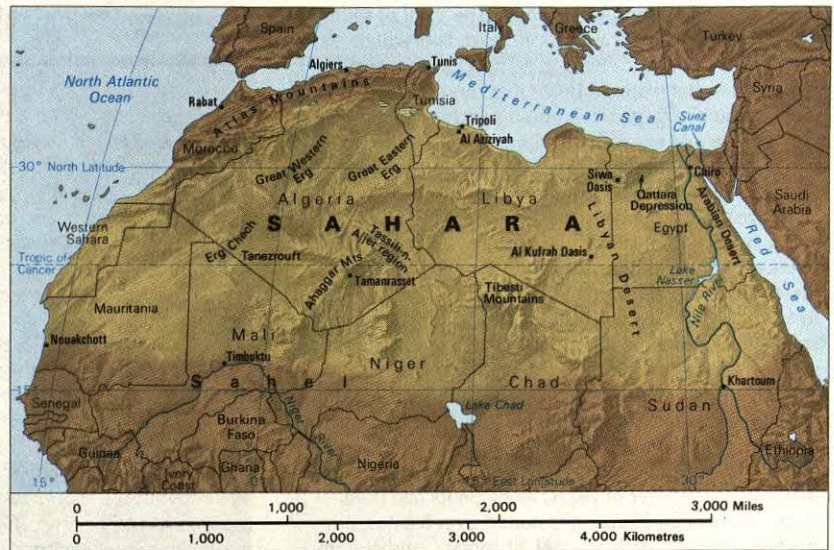
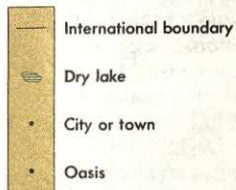
About the time of Jesus Christ, camels were introduced into the Sahara from the Middle East. Long camel caravans crossed the desert along trade routes controlled by the Berbers. Southbound caravans carried cloth, salt, glass beads, and other products. From the south, the caravans brought slaves, gold, kola nuts, leather, and pepper to markets in northern Africa.

The Roman Empire, which reached its peak from A.D. 40 to 235, included the northern borders of the Sahara. The Romans built cities and roads and brought improved farming practices to the area. The Vandals, a Germanic people, conquered northern Africa in the 400's.

During the 600's and 700's, Arab tribes invaded northern Africa and began to convert the people to Islam, the religion of the Muslims. By the 1000's, the Arabs had spread Islam to the southern borders of the Sahara. Ara-

The Sahara

The Sahara stretches across northern Africa from the Atlantic Ocean to the Red Sea, and from the Atlas Mountains to the Sahel region. The desert covers parts of 10 countries.



bic eventually became the chief language of the Saharan people.

European exploration of the Sahara began in the early 1800's. France, Spain, Italy, and Great Britain occupied parts of the Sahara from the late 1800's to the mid-1900's. By the 1960's, all the areas occupied by the European powers, except Spanish Sahara, had become independent countries. Spain gave up control of Spanish Sahara in 1976, and the region came to be called Western Sahara.

Since the late 1960's, severe droughts have struck much of the Sahel, an area of Africa that lies along the southern borders of the Sahara. Some people blame the droughts on expansion of the Sahara. But the droughts are actually part of normal, periodic climate variations in the area.

Related articles in *World Book* include:

Africa	Berbers	Harmattan
Algeria (The Sahara; picture)	Camel	Oasis
Arabs	Desert	Sirocco
Bedouins	Egypt (physical map; picture)	Tuareg

Sahel is an area in Africa that has severe *droughts* (dry periods). The Sahel lies south of the Sahara, and extends through large parts of Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, and Sudan. Some geographers also consider the dry regions of Ethiopia, Kenya, and Somalia to be part of the Sahel. A number of serious droughts have struck the Sahel. The area has been especially dry since 1968. Millions of people in the Sahel have died as a result of crop failures caused by drought.

Farmers in the Sahel face many problems. During some seasons, the area either receives no rain, or the rains come too late for the growing season. Occasionally, the Sahel receives heavy rainfalls that wash away the farmer's seeds. Other problems include livestock epidemics, attacks by locusts that destroy crops, and *erosion* (wearing away) of farmland resulting from overgrazing, wind, and rain. Agricultural experts have

developed methods to improve farming in drought-stricken areas such as the Sahel. But more economic assistance and cooperation by the governments of the area are needed before these methods can be widely applied.

Said, Nuri as- (1888-1958), an Iraqi army officer and politician, served as prime minister of Iraq on fourteen different occasions. He was known for his efforts to promote Arab unity.

Nuri as-Said was born in Baghdad. In 1909, when Iraq was still part of the Ottoman Empire, he became an officer in the Turkish army. In 1916, during World War I, he joined Emir Faisal's guerrilla army in revolt against Ottoman rule and served as his chief of staff. He continued to serve Faisal after Faisal became king of Iraq.

In 1930, Said became prime minister of Iraq for the first time. As prime minister, he negotiated an independence treaty which preserved much British influence. In 1955, he took Iraq into the Baghdad Pact, an alliance whose other members were Great Britain, Pakistan, Persia (now Iran), and Turkey. His pro-British policies eventually cost him his life. In 1958, Said and King Faisal were overthrown when the nationalist army seized power. Said was hacked to death by a mob when he tried to flee Baghdad disguised as a woman.

Saigon. See **Ho Chi Minh City**.

Sail. See **Sailing**; **Ship**; **Ship, Model**.

Sailfish is a large fish that has a large dorsal fin that spreads out like a sail. These powerful game fishes are caught on light rod-and-reel tackle worldwide, particularly in the warm waters off North, Central, and South America. Sailfish around Florida are sometimes 1.5 metres long and weigh 54 kilograms. The largest caught in Pacific waters weighed 100 kilograms. The upper jaw is sharp and long, like that of the marlin, to which it is related. Sailfish use their long bill to stun prey.

Scientific classification. The sailfish belongs to the family Isthiophoridae. It is classified as *Istiophorus platypterus*.

See also **Fish** (picture: Fish of coastal waters and the open ocean).

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Sailing is an exciting water sport. The thrill of sailing a boat in a fresh breeze attracts thousands of sailors to seashores, lakes, and rivers in all parts of the world. They take to the water in boats that range in size from tiny dinghies to large ocean-going yachts.

Many people enjoy the excitement of racing their boats against other craft. For some, sailing brings the pleasure of leisurely hours on the water. Many people also love the challenge that sailing offers to their skill.

For hundreds of years, all great navies and merchant fleets of the world consisted of sailing vessels. Tall-masted ships with huge, billowing canvas sails travelled to all parts of the world. By the early 1900's, however, steamships had almost completely replaced sailing vessels for military and commercial purposes (see *Ship* [Sailing ships in the 1900's]). The development of sailing as a sport began when sailing ships declined in commercial importance.

Professional boatbuilders make most pleasure sailing boats. For a number of years, many boats had hulls made of wooden planking fastened over frames. But newer materials, such as steel, fibreglass, and aluminium, are now used. However, some amateurs build small wooden sailing boats at home. The parts are sometimes supplied in a kit, and the builder simply fits them together. This is an especially popular way of building a first boat, although with the advent of mass produced fibreglass boats, many amateur builders buy a hull and deck structure from a professional builder, and finish building the boat themselves. Dinghies and large sea-going yachts are sometimes built in this way.

The parts of a sailing boat

Each part of a sailing boat has a special name. Sailors take great pride in using the proper terms. The main parts of a sailing boat include (1) the hull, (2) the spars, (3) the sails, and (4) the rigging.

Hull is the body of a boat. The front of the hull is called the *bow*, and the rear is called the *stern*. *Forward*, or *fore*, means *front*, and *aft* means *rear*. Almost all boats have either a *keel* or a *centreboard*. These flat pieces of metal or wood extend into the water from the bottom of the hull to prevent movement to either side. A keel is fixed in place. But a centreboard can be raised or lowered through a slot in the bottom of a hull. An older form of centreboard is the leeboard. Instead of one fin going down through the middle of the boat, there are two—one at each side. These are lowered when needed to stop the craft sliding sideways, and can be seen on large sailing craft, especially in Holland. The boat is steered with the *rudder*, a fin that extends vertically into the water near the stern. On small sailing boats, the rudder is turned with a long handle called a *tiller*, and on larger boats with a *wheel*.

Spars are the poles that support the sails. They include masts, booms, and gaffs. *Masts* are the upright poles that hold the sails. The *mainmast* holds the largest sail. Some large sailing boats also have a shorter mast, called a *mizzenmast*, toward the stern, or a shorter *foremast* toward the bow.

Booms and *gaffs* are the poles that extend at right angles to the masts and hold the sails straight out. Booms



The thrill of sailing attracts many people to this exciting sport. Sailors meet regularly throughout the year to sail for fun or in competitions.



A yacht's *galley* (kitchen) often has all the appliances a sailor needs to prepare a wide variety of hot meals.

are fastened to the bottom of the sail, and gaffs are sometimes fastened to the top.

Sails. The *mainsail* (largest sail on a boat) is fastened to the back of the mainmast. A smaller, triangular sail in front of the mainmast is called a *jib*. A large jib that overlaps the mast and stretches far back next to the mainsail is called a *Genoa*, after the Italian port where it was first used. The *spinnaker* is a large, balloon-shaped sail used for added speed when a boat sails with the wind. Spinnakers are often made in red, blue, and other bright colours.

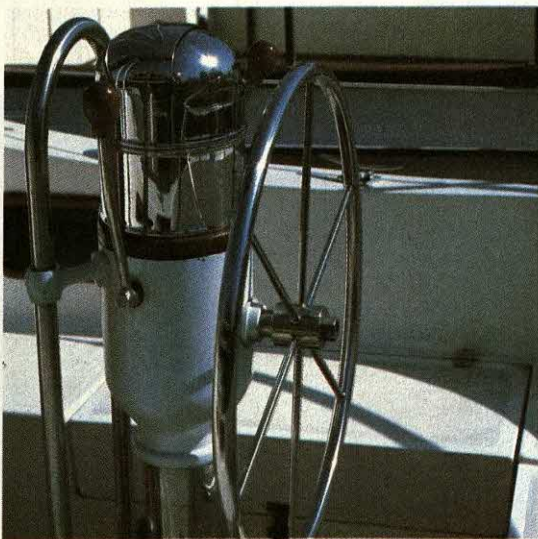
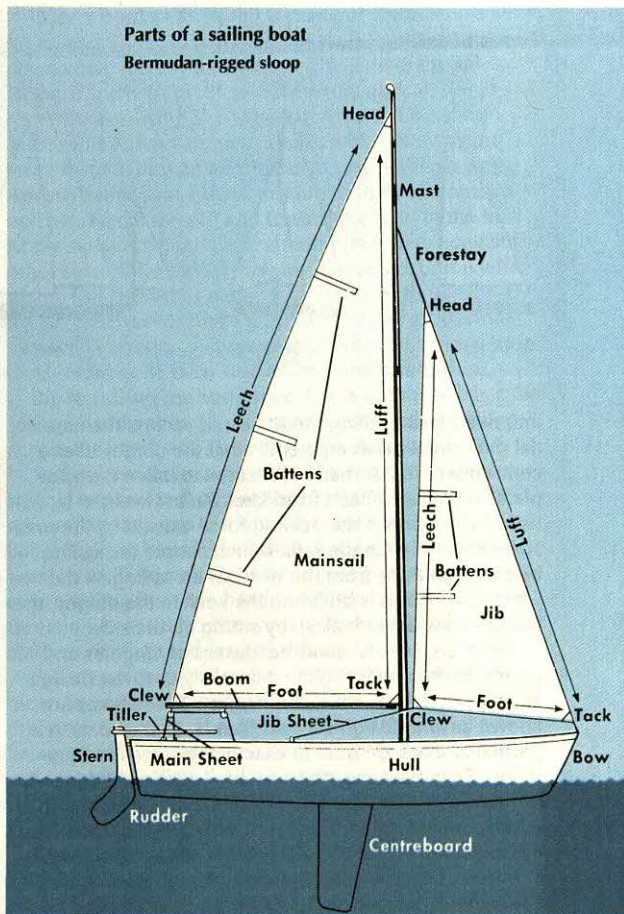
Terylene has largely replaced cotton as a material for sails. This material is strong and tightly woven, and holds its shape well no matter how strong the wind blows. But spinnakers are usually made of nylon, which is strong, light, and elastic. Nylon is too elastic a material for other sails.

Rigging is the *lines* (ropes) used on a sailing boat. *Standing rigging* is permanent and supports the masts. It includes *shrouds* that run from the sides of the boat to the mast, and *stays* that run from the bow and stern to the mast. *Running rigging* consists of the lines used to adjust the sails and booms. The lines that raise and lower the sails are called *halyards*. Those used to *trim* (adjust) the sails are called *sheets*.

Kinds of sailing boats

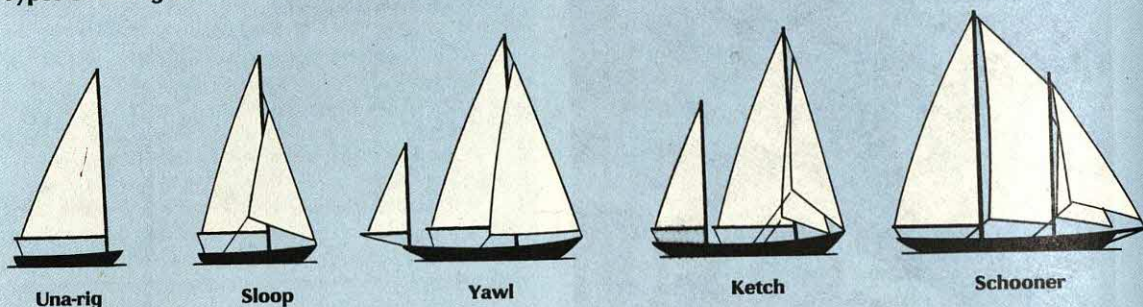
Sailing boats are classified according to their size and the way their sails and masts are *rigged* (arranged). There are many combinations of sails and masts. The most common rigs include una-rig, sloops, yawls, ketches, and schooners. Most small sailing boats are sloops. Larger sailing boats, especially those capable of ocean trips, are often yawl, ketch, or schooner-rigged in order to break total sail area into smaller, more easily managed parts.

Dinghies and yachts. Sailing boats can be classified



The wheel is used to turn the rudder and steer larger sailing boats. Small boats are steered with a long handle called a *tiller*.

Types of sailing boats



into two types—sailing dinghies and yachts. The essential difference between them is that the dinghy uses a centreboard (if it is made of metal it is called a centre-plate) and a yacht has a fixed keel. *Ballast* (weight) is used to counteract the heeling force caused by the pressure of the wind in the sails, which causes the sailing boat to lean away from the wind when sailing. In the yacht, this ballast is built into the keel; in the dinghy, the human crew act as ballast, by sitting on the side.

There are several hundred classes of dinghies and yachts. Each is built slightly differently as to the design and size of its hull, sails, and rigging. These boats are known as *one-design* classes. That is, all the boats in a particular class are built to exactly the same measurements. Each class has its own name, such as *Dragon*, *Enterprise*, and *Star*. The *Mirror* and *Laser* are among the world's most popular classes of sailing boats. Each class includes more than 100,000 boats in about 25 countries.

Yawls, ketches, and schooners are larger and usually more expensive boats. All have two masts and may be as long as 33 metres. A *yawl* has at least three sails—a

jib, a mainsail, and a mizzen sail. The mizzenmast stands in the stern behind the rudder post. A *ketch* also carries three or more sails, but the mizzenmast is in front of the rudder post. A *schooner* has a mainmast in about the middle of the boat and a foremast. It has the most sails, with one or more jibs, a foresail, and a mainsail. These larger boats may have comfortable living quarters that make them popular for long trips. If they have engines to help them sail into and out of harbours, they are called *auxiliary sailing yachts*.

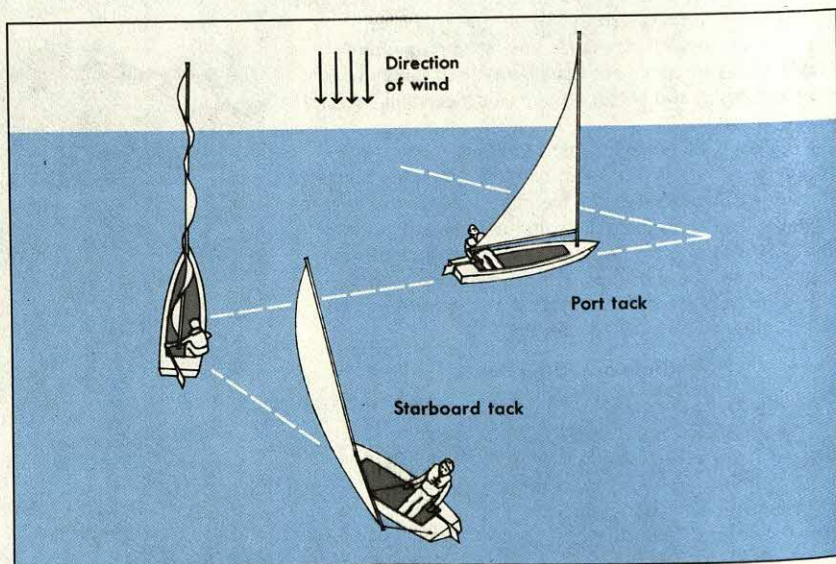
Sailing a boat

Even a log raft with a goatskin tied to a pole will sail before the wind. To sail in other directions, a boat must be designed and rigged so that the force of the wind moves it across the wind or into the wind, as well as moving it with the wind.

Controlling direction. A boat with no means of control will travel straight *downwind* (in the direction toward which the wind is blowing). It will do this no matter which direction its bow or stern is pointing. It may

Basic sailing manoeuvres

Sailing requires skill, knowledge, and experience. Three basic manoeuvres that all sailors must know are how to sail (1) into the wind, (2) across the wind, and (3) with the wind.



Sailing into the wind is also called *tacking to windward*. To sail into the wind, a boat *tacks* (zig-zags) at a 45-degree angle to the direction of the wind. The boat must tack because if it sailed directly into the wind, the sail would flap wildly and be useless.



A boat **tacks** when sailing into the wind. The crew manoeuvres the boat by changing the position of the rudder and the sails.

even go sideways. Using a rudder is the first step in controlling a boat. With a rudder, the bow of the boat can be pointed in the desired direction.

But a rudder is not enough to control a boat. A boat must also have something to keep it from sliding sideways when moving across the wind. This is done with a keel or centreboard, or with twin leeboards. Boats with keels can sail only in water deeper than the keel. Boats with centreboards or leeboards can sail in shallower water, because the centreboard or leeboard can be raised or lowered. Leeboards are a simple way of changing a canoe or rowing boat into a sailing boat.

With a rudder for steering and a keel or centreboard to prevent sideward movement, a sailing boat can travel in many directions. The bow is usually sharply pointed, so it can cut through the water easily.

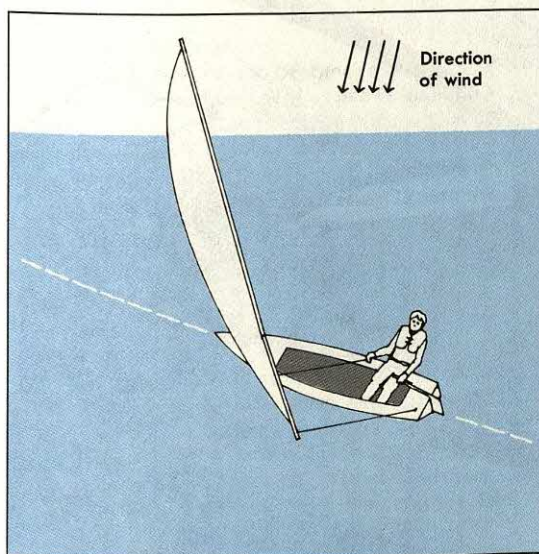
Why a boat sails. A sail is made of cloth panels sewn together so it will be shaped like the wing of an aeroplane when the wind fills it out. The side of the sail to *leeward* (away from the wind) corresponds to the top of an aeroplane wing. The action of the wind blowing across this curved surface creates a lift similar to the force that enables an aeroplane to stay in the air (see **Aerodynamics**). In a boat, this lifting force becomes a pull away from the sail and toward the bow of the boat. At the same time, the wind also exerts a push against the other side of the sail. In this way, the action of the wind on the sail combines in two ways to force the boat forward. These forces make it possible to sail a boat in almost any direction, except directly into the wind and up to 45 degrees on each side of the wind direction.

Basic sailing manoeuvres. There are three basic sailing manoeuvres: (1) sailing into the wind, (2) sailing across the wind, and (3) sailing with the wind.

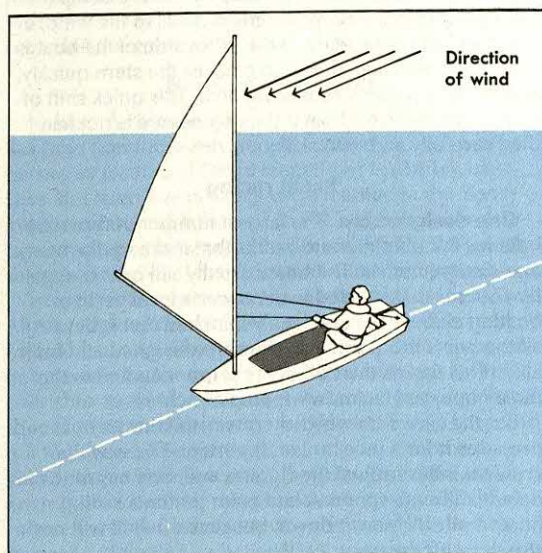
Sailing into the wind is called *tacking to windward*, *sailing on the wind*, or *beating to windward*. No boat can sail directly into the wind. If it does so, the sail flaps like a flag and becomes useless. But a boat can sail upwind by *tacking*, or following a zig-zag course. In general, a sailing boat can head to within 45 degrees of the direction from which the wind is blowing before its sail starts to *lift* (flap) and lose its driving force.

Sailing to windward requires great skill. The wind almost never blows constantly with the same force from the same direction. The speed with which a sailor's tacks bring a boat to a certain point upwind depends on the sailor's ability to feel the little shifts and changes in the wind, and to adjust the sails and the boat's direction, or course, accordingly.

Sailing across the wind, with the wind *abeam*, is called *reaching*. Sailing boats can usually move faster when sailing across the wind than in any other direction. Some light boats with flat bottoms can move fast



Sailing across the wind is also called *reaching*, or sailing with the wind *abeam*. A boat can usually sail faster when moving across the wind than it can with any other manoeuvre.



Sailing with the wind, called *running*, is the slowest basic manoeuvre. The sail is at almost a right angle to the direction in which the boat is moving, which creates great wind resistance.

enough in a good breeze to lift out of the water and *plane* on the surface like a speedboat. This gives a great sensation of speed even though the boats seldom travel more than 32 kilometres per hour.

Sailing with the wind is called *sailing before the wind* or *running*. Contrary to what might be expected, running is not so fast as reaching. In running, the sail is simply pushed along by the wind and makes its own resistance. Many racing boats use spinnakers for added speed when running. These sails lift the boat along.

Trimming and tacking are two basic skills all sailors must learn in order to handle their boats effectively.

Trimming means adjusting the sails to obtain the full advantage of the available wind. A sailor must always know the wind direction in order to trim the sails correctly. When the boat is running before the wind, the mainsail is at right angles to the boat's direction. If a spinnaker is used, it is rigged out on one side of the mast on its own boom, called a *spinnaker pole*. The mainsail is on the other side of the mast. When the boat is sailing across wind, the mainsail extends about half-way out from the boat, or at about a 45-degree angle to its direction of travel. When the boat is sailing into the wind, the sails should be trimmed nearly parallel to the boat's direction.

Small sailing boats can easily *capsize* (overturn) if mishandled. Experienced sailors know where to place their weight and how to relieve dangerous pressure on the sails if a boat tips too far. This is done by *spilling wind* (letting the sails out) so some of the wind spills from them and they begin to flap. If a boat does capsize, the crew should hang on to it until rescued, unless it is of a type that can be righted and sailed. All sailors, especially those who are weak swimmers, should always wear life jackets. See **Swimming** (Water safety).

Tacking involves turning the boat so that the wind comes at it from the opposite side. When sailing into the wind, this is called *going about*. In going about, the bow is turned so that the wind crosses it. This is a comparatively safe manoeuvre. When the stern is to the wind, a turn that brings the wind to the other side of the boat is called *gybing*. Then, the wind crosses the stern quickly, and the boom slams across the boat. This quick shift of forces can capsize a boat if the manoeuvre is not handled carefully and with skill.

Yacht racing

One-design races. The largest number of races are held for the dinghies and yachts that make up the many one-design classes. The boats usually sail over triangular courses in protected waters near a local yacht or boating club. These are evenly matched races, because all the boats in a particular class are designed and built alike. This makes the skill of the skipper and crew the most important factor in winning a yacht race.

But the care with which a crew maintains its boat and prepares it for a race is also important. The way the crew members adjust the rigging and sails has much to do with a boat's speed. A bad paint job on a sailing boat's hull will slow it down, because the hull will not slip through the water easily.

Handicap races involve boats of different sizes and designs. All the boats cross the starting line together, but the smaller boats have a *handicap* (time allowance).

A smaller boat can win even though it finishes far behind a larger boat. Most long ocean races for larger yachts are handicap races. One of the most famous races is the Fastnet race, held every two years from Cowes in England, round the Fastnet rock off Ireland and back to Plymouth, England. The world's longest yacht race is the Whitbread Round the World Race, which starts and finishes in England, circles the globe and lasts for nine months.

America's Cup is the world's most famous sailing competition. Traditionally, a yacht representing one nation challenges the defending champion for a cup first won in 1851 by the schooner *America*. Elimination races determine the yachts that will represent the defending champion and the challenger. The yacht that first wins four individual races wins the cup.

Related articles in *World Book* include:

America's Cup	Galleon
Boating	Galley
Brig	Junk
Caravel	Lipton, Sir Thomas Johnstone
Catamaran	Olympic Games (table: Yachting)
Chichester, Sir Francis	Ship
Clipper ship	Transportation (pictures)
Flag (Flags that talk)	
Frigate	

Outline

I. The parts of a sailing boat

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| A. Hull | C. Sails |
| B. Spars | D. Rigging |

II. Kinds of sailing boats

- A. Dinghies and yachts
B. Yawls, ketches, and schooners

III. Sailing a boat

- | | |
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| A. Controlling direction | C. Basic sailing manoeuvres |
| B. Why a boat sails | D. Trimming and tacking |

IV. Yacht racing

- | | |
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| A. One-design races | C. America's Cup |
| B. Handicap races | |



The living room of this yacht, known by sailors as the saloon, has comfortable furniture and fine wood panelling.



The America's Cup is the oldest international sailing competition. Traditionally, yachts representing two nations compete in a series of individual races to determine the winner of the cup. In 1988, however, the American defender, *Stars & Stripes*, was a multihull boat called a catamaran instead of a yacht. *Stars & Stripes*, right, defeated the challenger, *New Zealand*, left, in two straight races off the coast of San Diego, U.S.A. In 1989, an American court disqualified *Stars & Stripes* and awarded the cup to New Zealand. Later that year, a higher American court reversed the decision and returned the cup to the United States.

Questions

How does a sloop differ from a yawl?
 What sail was named after an Italian port?
 In what direction would a boat be sailing if it is *reaching*? *Running*?
 When would a *spinnaker* be used?
 What is the world's most famous yacht race?
 Why is Terylene an excellent material for sails?
 On what basis are the various sailing boats classified?
 How does an *auxiliary sailing yacht* differ from other forms of dinghy or racing yacht?
 Why is a *gybing* turn difficult for a sailing boat?
 How does a centreboard enable a sailing boat to enter shallow water?

Sailplane. See Glider.

Saint is a holy person who becomes a religious hero by exemplifying a virtue or virtues of a religion. The word comes from the Latin *sanctus*, meaning a *holy one*.

The followers of a religion regard its saints as unusually blessed. They believe these saints are able to give special blessings and to exercise certain superhuman powers. All the world's major religions *revere* (deeply respect) saints, but in different ways. Some religions have formal procedures for officially granting sainthood. Other religions do not formally recognize saints, but they have religious practices that honour holy people.

Many people achieve sainthood because they played a major role in the history of their religion or because they symbolize a traditional feature of it. For example, Saint Paul converted to Christianity and became a great missionary who sought other converts. Some saints are martyrs who died for a holy cause. Many Christians who died rather than give up their faith during early Christianity are now considered saints.

A number of saints are considered especially close to God. Roman Catholics believe that the Virgin Mary is so loved by God that she rose bodily to heaven.

Some saints, such as Buddha, are believed to have

gained superhuman or special knowledge about, or insight into, holy mysteries. Eastern Orthodox Christians revere Saint John Chrysostom for his wisdom.

Some people are revered as saints because before or after death they performed miracles and pleaded with God for blessings or curses on particular people. Others achieved sainthood because their *relics* (remains or possessions) or some place associated with them came to be regarded as holy.

Still others are considered saints because before or after death they became *demigods* (partly a god and partly human) and had divine powers. Before World War II (1939-1945), believers in one form of Shintoism regarded the emperor of Japan as divine.

Non-Christian saints

Judaism forbids praying to any being other than God. But Jews honour saintly people as heroes. Such early heroes as Jacob and David sometimes broke Jewish laws. But later Jewish saints were learned in the *Torah* (religious law) and followed its rules of behaviour. Jewish saints have been called "toilers in the Torah." Jewish saints include Hillel the Elder and Akiba ben Joseph.

Islam credits supernatural powers only to *Allah* (God). All Muslims acknowledge as saints such heroes as Muhammad and Ali. The Islamic holy book, the Quran, does not provide for the worship of saints, but each locality cherishes a saint called *wali* (benefactor, companion, or friend). Muslim saints are considered to be close to God but not divine. The spiritual powers they exercised as living people increase when they die. Then, their influence centres on their tombs and relics, especially their robes. A visit to a saint's tomb, with its holy objects and its pool or fountain, is believed to provide advice, cure a disease, or grant children to a childless woman.

The Oriental religions have a greater variety of practices and beliefs regarding saints than do the Western

religions. Buddhism honours the buddhas and their close disciples, along with relics and sacred places associated with them. Buddhist monks and nuns recognize patron saints as special guardians, and Buddhist martyrs are honoured as religious heroes. Hinduism has no official saints for all Hindus. There are many ranks of semi-divine local or regional saints. A Hindu village, tribe, or religious order may raise its own heroes or protectors to sainthood. Confucianism has holy men who are *sages* (wise men) of intellectual and moral superiority. The most famous sage is Confucius. Shintoism has no human saints or martyrs because its holy people are considered divine.

Christian saints

The more traditional Christian denominations emphasize the honouring of saints. The Eastern Orthodox Churches, the Roman Catholic Church, some Lutheran churches, and the churches of the Anglican Communion regard many of the same people as saints.

A *canonized* saint is a person whose name is included in a *canon* (official list). Christian saints were first canonized by common agreement among local people, and later by regional bishops. Gradually, the authority to canonize saints for Latin Christians centred on the pope.

The earliest Christian writings call all believers *saints*. This practice has been renewed by several modern denominations, including the Mormons (Latter-day Saints). During the 200's, the term *saint* referred specifically to martyrs, and in the 300's to bishops. By the 500's, the term referred to all departed heroes and heroines of Christianity who were honoured in worship services.

After many heroes and heroines had entered the list of saints, their relics were considered able to give special blessings. Believers asked the saints to plead with God for special favours. By the early 1500's, many people prayed to the saints and their relics for special assurances of salvation.

During the Reformation, both Protestants and Catholics attacked abuses in the worship of saints. Most Protestants refused to revere any people as saints except certain heroes mentioned in the New Testament. After the Reformation, Catholic saints were clearly ranked lower than God. Roman Catholics, members of Eastern Orthodox Churches, and some Protestants still ask saints to plead with God on their behalf.

Roman Catholic saints

Present Roman Catholic procedures of canonization were officially established in the 1600's. A commission appointed by the church strictly examines the subject's life and works. If the investigation produces enough evidence, the person is eligible for *beatification*. That is, he or she may officially be declared "blessed." If further investigation produces proof of two miracles associated with the person, he or she may be canonized as a saint.

Canonization consists of declaring that a person believed to be holy was indeed a saint during his or her lifetime and is in heaven with God. This official status does not approve all that the individual said, did, or wrote. Among Roman Catholics, only the pope can grant official recognition to a person nominated for beatification or canonization.

In 1969, the Vatican announced a revision of the

church's liturgical calendar, which lists the feast days of saints celebrated by the church. The new calendar listed 58 saints. But many more saints could continue to be venerated locally. The Roman Catholic Church also made optional the celebration of the feast days of other saints.

Children of Catholic parents and many others are named after a saint, often the saint on whose day the child was born or baptized. That saint becomes the child's special guardian or patron. A number of cities, especially in the Western Hemisphere, are named after saints. They include Saint Louis, Missouri, U.S.A., and São Paulo (Saint Paul), Brazil. In many denominations, parish churches or congregations take the names of saints. Many Christians, recognizing that many holy men and women have never been canonized, celebrate them on All Saints' Day, November 1.

Related articles in World Book. See *Canonization*; *All Saints' Day*; and the table of popes with the *Pope* article. See also individual saints' names, such as *Cecilia, Saint*. Other related articles include:

Albertus Magnus, Saint	John, Saint
Alphonsus Liguori, Saint	John the Baptist, Saint
Andrew, Saint	Joseph
Anthony of Padua, Saint	Jude, Saint
Anthony of Thebes, Saint	Louis (IX)
Aquinas, Saint Thomas	Loyola, Saint Ignatius
Augustine, Saint	Luke, Saint
Bartholomew, Saint	Mark, Saint
Basil, Saint	Mary
Becket, Saint Thomas à	Matthew, Saint
Benedict of Nursia, Saint	Matthias, Saint
Brendan, Saint	Michael, Saint
Canisius, Saint Peter	Nicholas, Saint
Christopher, Saint	Pachomius, Saint
David, Saint	Patrick, Saint
Denis, Saint	Paul, Saint
Dominic, Saint	Peter, Saint
Edward the Confessor	Rose of Lima, Saint
Elizabeth, Saint	Ruiz, Saint Lorenzo
Francis of Assisi, Saint	Simon, Saint
George, Saint	Stanislas, Saint
Ignatius, Saint	Stephen, Saint
James, Saint	Teresa, Saint
James the Greater, Saint	Thomas, Saint
James the Less, Saint	Valentine, Saint
Jean Baptiste de la Salle, Saint	Vladimir I
Jerome, Saint	Xavier, Saint Francis
Joan of Arc, Saint	

Saint Albans (pop. 122,400) is a local government district in Hertfordshire, England, which takes its name from the city in its centre. The district includes the town of Harpenden. St. Albans city stands on the site of the Roman city *Verulamium*.

The remains of Verulamium include an amphitheatre and a mosaic pavement. St. Albans Cathedral was founded as an abbey in 797 by Offa, king of Mercia. Two battles of the Wars of the Roses were fought at St. Albans, in 1455 and 1460.

Saint Andrews (pop. 66,010) is a farming town on the Fife Region coast of Scotland between Edinburgh and Dundee. It is the home of the oldest university in Scotland and of the Royal and Ancient Golf Club.

St. Andrews has many reminders of its ancient past. Its cathedral was begun in 1160, and the ruins clearly show that it was once the largest cathedral in Scotland. The ancient castle is also now mostly in ruins. The Royal and Ancient Golf Club, founded in 1754, is one of the



St. Andrews is the home of the Royal and Ancient Golf Club. The town is famous throughout the world as a golfing centre.

best-known golf clubs in the world, and its governing body establishes many of the rules of the game.

See also **Fife Region**; **Golf**.

Saint Andrew's cross. See **Cross** (picture); **Flag** (picture: Crosses in the British flag).

Saint Andrew's Day commemorates the martyrdom of Saint Andrew, the patron saint of Scotland, in about A.D. 70. St. Andrew's Day is celebrated in Scotland on November 30. See **Andrew, Saint**.

Saint Anthony's fire. See **Erysipelas**.

Saint Augustine, Florida (pop. 11,985), is the oldest permanent settlement established in the United States by Europeans. It was founded in 1565 by a Spanish explorer, Pedro Menéndez de Avilés. St. Augustine lies in northeastern Florida, near the Atlantic Ocean.

Spain ruled St. Augustine for more than 200 years. Historians believe the Spanish explorer Juan Ponce de León visited what is now the St. Augustine area in 1513. During the late 1500's, St. Augustine served as Spain's military headquarters in North America. The English naval commander Sir Francis Drake looted and burned the settlement in 1586. Spain ruled St. Augustine until 1763, when the British gained control of it. Spain again ruled the settlement from 1783 until 1821, when Florida became a territory of the United States.

The narrow streets and Spanish-style architecture of the oldest district of St. Augustine reflect the city's rich history. Many of the old buildings have been restored to preserve the historical atmosphere of the district. The Castillo de San Marcos (Fort of Saint Mark), a large, grey stone fortress built by the Spanish in the 1600's, dominates the city. St. Augustine became an important tourist resort in the 1880's, and today tourism is the city's most important industry.

Saint Bartholomew's Day, Massacre of, was a slaughter of French *Huguenots* (Protestants). The massacre began in Paris on St. Bartholomew's Day, Aug. 24, 1572. It spread throughout France, and thousands of Huguenots were killed before the violence ended.

During the mid-1500's, the French Roman Catholics and Huguenots fought bitterly. The Huguenots had be-

come so numerous that the Roman Catholics feared they would take control of the French government. A civil war began in 1562 and lasted eight years. In 1570, the Peace of Saint-Germain granted the Huguenots liberty. But fear of the growing Huguenot political power led Catherine de Médicis, the mother of King Charles IX, and other Roman Catholic leaders to plot the assassination of leading Huguenots. The attempted murder of Gaspard de Coligny, one of the most respected Huguenot leaders, caused great tension in Paris.

Catherine convinced King Charles that the Huguenots would attack the palace and might kill him. Charles then ordered the death of leading Huguenots. He reportedly said, "Kill them all so that not a single one be left to reproach me." Henry de Guise, Coligny's enemy, led a group who murdered Coligny on St. Bartholomew's Day. Other well-known Huguenots were killed in Paris. Mobs then killed thousands of Huguenots throughout France.

See also **Huguenots**; **Catherine de Médicis**; **Charles (IX) of France**.

Saint Bernard is a large, intelligent dog that became famous for rescuing lost travellers. The dog was developed during the 1600's by a group of monks in the monastery of St. Bernard, in the Alps of Switzerland. At that time, many people travelled in the Alps on foot. Some lost their way, or became buried in sudden snowdrifts or snowstorms. The St. Bernard was trained to rescue such people. With its keen sense of smell, the St. Bernard could find people who were buried under the snow. After it had found the lost traveller, it called out for help by barking loudly. The dogs were also trained to guide travellers over treacherous trails, giving warning of dangerous footing. An English artist, Sir Edwin Landseer, painted the dog with a small cask hanging from a collar around its neck. But authorities say the St. Bernard never carried casks on rescue missions.

The St. Bernard is valued as a watchdog. It is also a good pet and guide for explorers. It is strong and tall, measuring about 65 to 75 centimetres high at the shoulder. It may weigh from 75 to 80 kilograms, and is one of the heaviest dogs. The dog has a white and red or white



The St. Bernard is a good watchdog and pet.

and brownish-yellow coat. A St. Bernard may also have some black markings on its head. Its hair may be either long or short. The St. Bernard has a large, square head, a short muzzle, and a short neck.

See also **Dog** (picture: Working dogs).

Saint Bernard Passes are two high passes across the Alps. The Great St. Bernard Pass is on the border between Switzerland and Italy, and the Little St. Bernard Pass is on the border between France and Italy. For their locations, see **Switzerland** (terrain map). The Romans used the passes as military roads about 2,000 years ago. Today, motor roads cross the passes. Each pass has a *hospice* (refuge for travellers). The Great St. Bernard Tunnel for cars, which is about 5.6 kilometres long, links Italy and Switzerland. It was opened to traffic in 1964.

Great St. Bernard. The road leading across Great St. Bernard begins at Martigny, in the Rhône Valley. It follows the Val d'Entremont to an elevation of 2,469 metres. The road then descends into northwestern Italy by way of Valle D'Aosta. The Great St. Bernard Hospice stands at the highest point in the pass. It was founded in the 1000's by Saint Bernard of Menthon. Augustinian monks offer refuge for travellers at the hospice. In the past, the

pass became well known because the monks used their famous St. Bernard dogs to save the lives of many wayfarers during severe winter months. In normal winters, the road to the pass is only partially open, isolating the hospice from the outside world. Food and other necessities are brought to the hospice by truck in the summer. In the winter, necessities are flown in by helicopter. Many summer travellers visit the hospice, which has room for more than 300 people. But only those travelling on foot may stay.

Little St. Bernard lies about 40 kilometres southwest of Great St. Bernard. Its hospice also dates from the 1000's, and is nestled in the pass at an elevation of 2,188 metres. Little St. Bernard is 16 kilometres south of Mont Blanc, the highest mountain in the Alps.

See also **Alps**; **Saint Bernard**.

Saint Christopher and Nevis is an independent island nation in the Caribbean Sea. The nation territory is made up of the two islands of St. Christopher (commonly known as St. Kitts) and Nevis. It lies 72 kilometres northwest of Antigua and Barbuda in the Leeward Islands, which are part of the Lesser Antilles group of the West Indies. The territory has a land area of 261 square kilometres. St. Kitts has an area of 168 square kilometres. Nevis, which lies about 3 kilometres southeast of St. Kitts, is 93 square kilometres in area. The state's official capital, Basseterre (pop. 14,725), is on the southern coast of St. Kitts. Charlestown is the capital of Nevis. The East Caribbean dollar is the basic currency. For a picture of the country's flag, see **Flag** (Flags of the Americas).

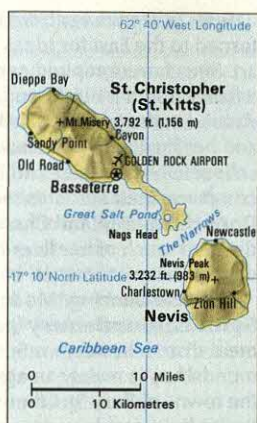
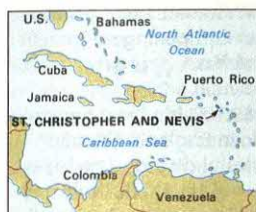
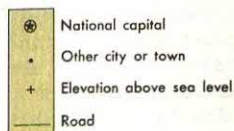
Government. The federation of St. Christopher and Nevis is a constitutional monarchy within the Commonwealth. A governor general, the British monarch's representative, is the symbolic head of state. The country has a *unicameral* (single-chambered) parliament, the House of Assembly. It has nine elected members and three nominated members, two of them nominated on the advice of the prime minister and one on the advice of the leader of the opposition. Elections are held every five years.

People. For the total population of St. Christopher and Nevis, see the *Facts in brief* table with this article. The people, known as Kittitians and Nevisians, are primarily of African ancestry. About 90 per cent of them



Great St. Bernard Hospice stands in Great St. Bernard Pass in the Alps, on the Swiss border with Italy. The hospice has been a refuge for travellers for nearly 1,000 years.

St. Christopher and Nevis



Basseterre is the capital and chief urban centre of the independent island nation of St. Christopher and Nevis.

are descendants of African slaves. Other ethnic groups are European, Asian, Indian, Syrian, and Lebanese. The official language is English.

Way of life. Two-thirds of the people of St. Christopher and Nevis live in rural villages scattered along the coast, and work on farms or plantations. The rest live in either Basseterre or Charlestown. Housing consists of elaborate concrete structures and the more traditional wooden houses. Throughout the history of the islands, various settlers brought their distinctive architectural styles, which were blended into the Caribbean environment. L'Hermitage, a house built by the Pembertons, a family who migrated from Wales, dates from 1740. It is one of the oldest wooden houses in the Antilles. A distinctive feature of this house is a wall partly covered by wooden shingles. A major popular event is the annual carnival, which takes place between December 24 and January 2. Other events include the St. Kitts and Nevis Sailing Regatta, Culturama Day, and a horse-racing competition in Nevis.

Religion. One-third of all religious adherents are Anglicans. Other denominations include Roman Catholics, Methodists, Baptists, Moravians, and Seventh-day Adventists.

Education is compulsory for children aged 5 to 16 years. Educational institutions include 25 primary schools, 6 secondary schools, 3 comprehensive mixed schools, and a college of further education consisting of a technical college, teacher-training college, a nursing school, and a sixth-form college. In addition, the School for Continuing Studies, a branch of the University of the West Indies, is located in St. Kitts.

Land and climate. The islands of St. Christopher and

Nevis are of volcanic origin. The highest peak, Mount Misery on the northwest of St. Kitts, is 1,156 metres above sea level. The highest peak on Nevis is Nevis Peak, which is 985 metres high.

Temperatures range from 20 to 29 °C. The average annual rainfall is about 109 centimetres. The months of May to November tend to be the wettest.

St. Christopher and Nevis is home to numerous *species* (kinds) of plants and animals. Among the plants are the poinciana, bougainvillea, and the hibiscus (the national flower). Animals include the vervet monkey and the pelican (the national bird).

Economy. The economy of St. Christopher and Nevis was once dependent on agriculture, especially sugar production. Today, agriculture accounts for only 7 per cent of the total goods and services produced. Manufacturing accounts for 12 per cent and services 68 per cent. Tourism is the most important service industry.

The chief agricultural product of St. Christopher and Nevis is sugar. In 1992, sugar output stood at 20,483 metric tons. There is a sugar refinery on St. Christopher. Other produce includes vegetables and fruit.

History. The earliest settlers of St. Christopher and Nevis were a people called the Arawak. They were followed by the more warlike Carib. Christopher Columbus sighted St. Christopher in 1493 and named it after the patron saint of travellers. When Columbus sighted the island of Nevis, he called it Nuestra Señora del las Nieves (Our Lady of the Snows), because its central mountain appeared to be snow-capped.

In 1623, Thomas Warner arrived and established a British settlement on St. Christopher, the first successful British colonization in the West Indies. During the 1600s, African slaves were imported to work on the sugar plantations. The island soon became the object of rivalry between the British and the French. In 1664, for example, the island was under French control. In 1713, it was ceded to the British under the Treaty of Utrecht.

Facts in brief about St. Christopher and Nevis

Capital: Basseterre.

Official language: English.

Area: 261 km².

Elevation: Highest—Mount Misery, 1,156 m.

Population: Estimated 1996 population—44,000. Estimated 2001 population—44,000.

Chief products: Agriculture—fruit, sugar, vegetables.

Money: Currency unit—East Caribbean dollar. One dollar=100 cents.

The French again captured part of it in 1782, but, under the Treaty of Versailles (1783), the British regained control and retained it until the 1900's.

Nevis had a similar experience. British colonists from St. Christopher settled in 1628. It came under attack by the Spanish and French. As with a number of Nevis' neighbours, the British eventually gained undisputed control under the Treaty of Versailles.

After emancipation in 1834, most ex-slaves remained on the plantations because they had no other choices. Later, the United Kingdom formed a territorial unit that included St. Kitts, Nevis, and Anguilla. These islands were jointly administered within the short-lived West Indies Federation (1958-1962). The three-island state became an Associated State with the United Kingdom in 1967. In 1969, Anguilla broke away from the federation. Anguilla was formally severed from the union in 1980. St. Christopher and Nevis became independent in 1983. In 1993, Prime Minister Kennedy Simmonds won a general election and retained power for his party, the People's Action Movement.

Saint Clair, Lake. See Lake Saint Clair.

Saint Croix. See Virgin Islands of the United States.

Saint David's Day is celebrated on March 1 in honour of the patron saint of Wales. Saint David was born probably in the A.D. 500's. He was bishop of the town in Dyfed now named St. David's. See **David, Saint**.

Saint Denis, Ruth (1879-1968), was an American dancer, dance teacher, and *choreographer* (creator of dance). She devoted herself to proving that dance could express "the noblest thoughts of man."



Ruth St. Denis was fascinated by Eastern and Oriental dances. She danced *Siamese Ballet* with her partner, Ted Shawn.

Ruth St. Denis was born in Newark, New Jersey. She turned to the East for ideas about dance as a spiritual art. She choreographed and performed in *Radha* (1906), a dance about a Hindu goddess. She also composed and danced in the Japanese ballet *O-Mika* (1913). In 1915, she and her husband, Ted Shawn, opened the Denishawn school in Los Angeles and formed the Denishawn dance company. Their students included Martha Graham, Doris Humphrey, and Charles Weidman. Ruth St. Denis devoted much of her later life to composing religious dances that were staged in churches.

See also **Dancing** (Modern dance).

Saint Edmundsbury (pop. 89,100) is a local government district in western Suffolk, in England. Saint Edmundsbury is mainly an agricultural district. It includes the towns of Bury St. Edmunds and Haverhill. Both towns have a wide variety of light industries. Bury St. Edmunds is also an important market town and tourist centre for East Anglia.

Saint Elias Mountains are a rugged series of the world's highest coastal mountains. They stand along the southeastern boundary of Alaska, U.S.A., and the Yukon Territory, Canada. The range is nearly 480 kilometres long. It has a maximum width of 160 kilometres, excluding the coastal plain and foothill belt.

The second and fourth highest peaks in North America stand in the Saint Elias Mountains. They are Mount Logan (5,951 metres) in the Yukon Territory, and Mount St. Elias (5,489 metres) in Alaska.

The ruggedness of the range prevents extensive exploration. Many peaks are unnamed. The mountains are composed chiefly of sedimentary and volcanic rocks of the Palaeozoic and Mesozoic ages (see **Earth** [table: Outline of the earth's history]). The range has frequent rains. Glaciers can be found throughout the mountain area.

Saint Elmo's fire is the glow that accompanies a steady discharge of electricity from certain objects. It occurs during thunderstorms or at other times when electrified clouds are present, and it is visible only in complete darkness. In the past, St. Elmo's fire was commonly seen around the masts of sailing ships. Today, people sometimes see it around the propellers and wing tips of aeroplanes that are flying through electrified clouds. A few people have reported observing St. Elmo's fire around the horns of cattle. The name *Elmo* is a form of *Erasmus*. Saint Erasmus was considered the patron saint of Mediterranean sailors.

See also **Jack-o'-lantern**; **Lightning** (Forms of lightning).

Saint Eustatius (pop. 1,781), also called *Statia* or, in Dutch, *Sint Eustatius*, is an island in the Caribbean Sea. It lies in the northern (Windward Islands) group of the Netherlands Antilles and is part of the kingdom of the Netherlands (see **Netherlands Antilles**, **Windward Islands**). The island is 21 square kilometres in area. The population, which is English-speaking, is concentrated in the capital Oranjestad on the southwestern coast of the island.

Although breadfruit, banana groves, and palm trees grow in its sheltered western coast, St. Eustatius is too dry to support much agriculture. There is some lobster-fishing. Tourism is of increasing importance. A regular air service links St. Eustatius with nearby Saba and St. Martin. Attractions on the island include its two extinct

volcanoes, one of which, the Quill, has a tropical forest growing in its crater.

St. Eustatius was first colonized by the French and British in 1625. Dutch, French, and British settlers fought over it, and the island changed hands many times. But it prospered as a centre of the slave trade. In the late 1700s, St. Eustatius supported the American colonies in their struggle for independence from Britain (now the United Kingdom). The British captured St. Eustatius in 1781 and the economy went into decline.

Saint-Exupéry, Antoine de (1900-1944), a French aviator, created the literature of aviation in France. However, he is probably best known for his fantasy, *The Little Prince* (1943). In the story, a young prince from a distant planet tells the author of his experiences as he wandered among the planets seeking wisdom. Saint-Exupéry often wrote about his own search for the meaning of life and death. *The Little Prince*, like his other major writings, reflects his regard for human values and his opposition to all abuses of the human spirit. Saint-Exupéry was born in Lyon.

Saint-Gaudens, Augustus (1848-1907), was an American sculptor. His works include public monuments, portraits, and symbolic figures. He created sculptures in a simple, naturalistic style, reducing details to express the essential character of the subject.

Saint-Gaudens' first major triumph was a vigorous, heroic bronze statue for the Admiral David Farragut monument (1881) in Madison Square in New York City. The *Shaw Memorial* (1897) in Boston Common honours the commander of a black Civil War regiment. Saint-Gaudens created standing and seated statues of Abraham Lincoln for Chicago parks in 1887 and 1906. His *General William Tecumseh Sherman* on horseback (1903) stands at the entrance to Central Park in New York.

Saint-Gaudens was born in Dublin, Ireland, but grew up in New York City. He studied at the National Acad-

emy in New York City, the École des Beaux-Arts in Paris, and in Rome.

Saint George Island. See Pribilof Islands.

Saint George's (pop. 7,500) is the capital and chief port of Grenada, an island nation in the West Indies. The city lies on the southwest coast of Grenada, one of the Windward Islands. For location, see Grenada (map).

In 1650, the French founded a settlement near what is now St. George's. The town was moved to its present site in 1705. The British gained control of Grenada in 1783, and St. George's later became the centre of government of all the Windward Islands. Grenada gained independence on Feb. 7, 1974, and St. George's became the capital. The city's main industry is tourism.

Saint George's Channel is an arm of the Atlantic Ocean that separates Wales from southern Ireland. It is about 160 kilometres long and from 97 to 160 kilometres wide. The channel runs from Holyhead and Dublin to St. David's Head, joining the Irish Sea with the Atlantic Ocean.

Saint George's Day is observed in England on April 23 in memory of the country's patron saint (see *George, Saint*). On this day, the flag of St. George flies from church towers and many other buildings (see *Flag* [Crosses in the British flag]).

Saint George's Island. See Bermuda (Location, size, and description; map).

Saint-Germain, Treaty of. The Allied powers of World War I (1914-1918) and the republic of Austria signed the Treaty of St.-Germain on Sept. 10, 1919. Twenty-seven Allied and associated countries signed the agreement, which broke Austria's power. Romania and the country later called Yugoslavia were the only two Allied countries that delayed signing. These countries objected to treaty guarantees given to minority groups. Several months passed before they were persuaded to sign the document. The Austrian National Assembly ratified the treaty on Oct. 17, 1919, and the agreement went into force on July 16, 1920. The United States, which signed the treaty but never ratified it, made a separate peace with Austria on Aug. 24, 1921.

Part I of the Treaty of St.-Germain provided that Austria could be admitted to the League of Nations after a period of good behaviour. Part II reduced Austria's territory from about 297,800 square kilometres to only 83,835 square kilometres and the population from 30 million to 6 million. Eight clauses guaranteed the independence and safety of Austria's minority groups.

The Treaty of St.-Germain gave complete independence to Poland, Czechoslovakia, Hungary, and the country later called Yugoslavia. These nations, together with Italy, also gained much territory that Austria had controlled before the war. Military clauses reduced the Austrian army to 30,000 soldiers. Only one factory could manufacture arms. Much of the Austro-Hungarian navy passed to the Allies. One of the important clauses of the Treaty forbade union between Austria and Germany. But in 1938, Hitler forced a union with Austria. World War II (1939-1945) set aside the treaty.

Saint Gotthard Pass is a famous mountain pass in the Lepontine Alps of southern Switzerland. It is a level depression, surrounded by a number of small lakes. The Rhine and Rhône rivers begin near the pass. A road with many hairpin turns crosses the pass at 2,114 metres



A Saint-Gaudens statue of General William Tecumseh Sherman stands at the entrance to Central Park in New York City.

above sea level. The rich farming and industrial valley of the Po River in northern Italy lies south of the pass.

Travellers first used the pass in the 1200's. The League of Three Cantons, the first three "states" of early Switzerland, guarded approaches to the pass during these early years. A hospice was founded in St. Gotthard Pass in the 1300's to give aid to travellers.

Saint Gotthard tunnels are two tunnels—one a road tunnel and the other a railway tunnel—that run through the Alps in southern Switzerland. The road tunnel, called the St. Gotthard Road Tunnel, is the world's longest motor vehicle tunnel. It is 16.3 kilometres long. The railway tunnel is 15 kilometres long.

The tunnels run nearly parallel to each other about 1,200 metres above sea level. They provide an easy crossing of the Lepontine Alps on the route between Zurich, Switzerland, and Milan in northern Italy. For location, see **Switzerland** (map). The railway tunnel was built between 1872 and 1882. The road tunnel was completed in 1980.

Saint Helena is an island in the Atlantic Ocean. It lies about 1,930 kilometres off the southwest coast of Africa, and about 1,100 kilometres southeast of Ascension Island, which is the nearest land (see **Atlantic Ocean** [map]). The island is a United Kingdom dependency in the Commonwealth of Nations. St. Helena is famous because Napoleon Bonaparte was forced to live there from 1815 until his death in 1821 (see **Napoleon I**).

The Portuguese discovered St. Helena in 1502, but it has belonged to Britain since 1673. St. Helena serves as the administrative centre for certain other British islands in the southern part of the Atlantic Ocean. These include Ascension Island and the Tristan da Cunha group, which consists of Tristan da Cunha, Gough, Inaccessible, and Nightingale islands.

St. Helena is rough and mountainous. It covers 122 square kilometres of lonely, volcanic wasteland. Barren cliffs rise 300 metres above sea level. The only village and port is Jamestown, the island capital. It lies at the mouth of a small mountain stream near James Bay. St. Helena has a population of about 5,600. The people are Europeans, East Indians, and Africans.

Less than a third of St. Helena can be used for growing crops. The chief crop is New Zealand flax. Cattle and sheep graze on grasslands. The government has helped

set up factories to make fibre mats. Other industries include fish curing and lacemaking.

See also **Ascension**.

Saint Helens (pop. 175,300) is a metropolitan district and manufacturing centre in Merseyside, England. The town is the United Kingdom's largest glass-manufacturing centre. Its works produce flat and safety glass, tableware, and containers. Other industries include engineering and the production of clothing and pharmaceuticals. Coal mines lie near the town. The first English canal was built in Saint Helens to take coal to Liverpool, via the Mersey River. The canal opened in 1757. Also within the district is Haydock Park racecourse. St. Helens also has a successful Rugby League football team. See also **Merseyside**.

Saint Helens, Mount. See **Mount Saint Helens**.

Saint James's Palace is a royal mansion in London. It stands in Westminster, north of the Mall. Henry VIII built the original palace, but little remains today. The architect Christopher Wren made the most important additions to the palace in the early 1700's, but the Chapel Royal retains its Tudor character. St. James's Palace was a main royal residence from Queen Anne's reign until the death of William IV in 1837. Queen Victoria preferred the nearby Buckingham Palace and transferred the royal residence there in 1837.

See also **Chapel Royal**; **Court of Saint James's**; **Grace and favour**.

Saint John, Order of, is a nondenominational Christian order devoted to the relief of human suffering. It provides services to people of all races, religions, and social classes. The order's full name is The Most Venerable Order of the Hospital of St. John of Jerusalem. Membership in the order is an honour granted with the approval of the queen of England. The order operates mainly through two foundations—the St. John Ambulance and the St. John Ophthalmic Hospital.

The St. John Ambulance is made up of over 250,000 unpaid volunteers who are trained to give first aid at public gatherings. It treats more than 1 million people in over 40 countries. It also holds classes for the public in first aid and related subjects. The St. John Ophthalmic Hospital, an eye treatment centre in Jerusalem, is supported by voluntary donations. The hospital also operates mobile units.

The Order of St. John stems from a medieval order, the Knights of St. John (see **Knights of Saint John**). The present order was established in the United Kingdom by royal charter in 1888. Headquarters are in London.

Saint John Ambulance is an organization that works to maintain the health of the community. It has branches in many parts of the world, including Australia, the Caribbean, Hong Kong, India, Kenya, Singapore, the United Kingdom, the United States, and Zimbabwe.

The St. John Ambulance Association acts as an educational body. Its aim is to teach people different forms of health care. These include first aid in case of accidents,



Order of St. John seal



Napoleon's home on St. Helena is near Jamestown. From 1815 to 1821, Napoleon lived in exile in the home, called Longwood.

child care, and personal hygiene. The Association also works to help sick and suffering people.

The St. John Ambulance Brigade actively provides health care. Most of its members are volunteers who provide first aid and auxiliary nursing to the community. The brigade's services are available in times of emergency. It also provides qualified first-aid attendants at public events. The organizers of such events generally make a donation to the brigade. The brigade also provides help for senior citizens and disabled people, and assists the staff in hospitals.

Saint John Ambulance developed from the Order of St. John, founded by monks in Italy in the 1000's. The original members offered medical care and help to pilgrims travelling to Jerusalem. The order spread through Europe. It flourished in England until King Henry VIII closed the monasteries in the 1530's.

The St. John Ambulance Association was founded in the United Kingdom in 1877, and the Brigade in 1887. It spread throughout the Commonwealth countries.

Saint John Lateran. See Lateran.

Saint John's is the capital of the island country of Antigua and Barbuda. Located in the northwest corner of Antigua, it has a population of 36,000, about half the island's inhabitants. The port is used by cruise ships and for cargo transportation. The main deep-water port has a channel 2,438 metres long and 91 metres wide. Heritage Quay is a duty-free zone.

Among the most notable buildings in St. John's is the Anglican St. John the Divine Cathedral. The earliest church on the site was built in 1683. The present cathedral dates from 1845. Other interesting sites are Redcliffe Quay, the island's former slave-trading quarter, and the Old Court House, built in 1749, which now houses the National Museum and Archives. St. John's is also the home of the Antigua Rum Distillery.

Saint John's-bread. See Carob.

Saint John's-wort, also called *hypericum* and *Rose of Sharon*, is a shrub with large yellow flowers. Most St-

John's-worts grow in the temperate and warmer regions of the Northern Hemisphere. They are usually low shrubs. Some are evergreen. The flowers bloom in clusters in summer. Pink and purplish flowers are rare. These bushes grow well in loam or moist, sandy soil. Most should have some shade. The larger St.-John's-worts form rounded bushes when they grow alone. The smaller ones make good low borders or ground cover. The goldflower is a hybrid. There are over 300 known *species* (kinds) of St.-John's-worts.

Scientific classification. The St.-John's-wort belongs to the St.-John's-wort family, Hypericaceae. The goldflower is *Hypericum* × *moserianum*.

Saint Kilda is an uninhabited group of islands in the North Atlantic. They lie about 64 kilometres west of the northernmost point of the island of North Uist, in the Outer Hebrides, Scotland. The islands are governed as part of Western Isles (see **Western Isles**). The islet of St. Kilda itself is a bird sanctuary. It also has an army base. Mouflon sheep live on a smaller nearby islet, Soay.

Saint Kitts. See Saint Christopher and Nevis.

Saint Lawrence, Gulf of. See Gulf of Saint Lawrence.

Saint Lawrence River is one of the most important rivers of North America and the second longest river in Canada. Only the Mackenzie River is longer. The St. Lawrence flows about 1,320 kilometres from its headwaters at Lake Ontario to its mouth in the Gulf of St. Lawrence. It drains an area of about 1,291,100 square kilometres, including most of southeastern Canada.

The St. Lawrence River links the Atlantic Ocean with the Great Lakes by means of the St. Lawrence Seaway (see **Saint Lawrence Seaway**). The river and the seaway help make the ports on the Great Lakes some of the busiest in the world. The St. Lawrence River served as the first highway of the explorers, fur traders, and colonists who went to Canada and the United States hundreds of years ago. The river is often referred to as the *Mother of Canada*.

The course of the St. Lawrence. The St. Lawrence River and the waterways that flow into it make up the St. Lawrence River system. The source of this system is the St. Louis River, which enters Lake Superior at Duluth, Minnesota, U.S.A. The system includes lakes Superior, Michigan, Huron, Erie, and Ontario and the rivers that connect them. It extends about 3,669 kilometres from its source to the Gulf of St. Lawrence. The St. Lawrence River itself begins at the northeast end of Lake Ontario and flows northeast. Like most rivers, the St. Lawrence River has an upper, middle, and lower part.

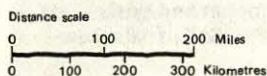
The upper St. Lawrence flows from Lake Ontario to Montreal. The first two-thirds of the upper part of the river form the boundary between Canada and the United States. All the rest of the St. Lawrence lies entirely within Canada and flows chiefly through the province of Quebec. The Thousand Islands, a group of over 1,700 islands, lie within a 64-kilometre section of the river as it leaves Lake Ontario. The river's chief tributary, the Ottawa River, flows into the upper St. Lawrence just west of Montreal.

Most of the upper St. Lawrence has an average width of 2 kilometres. But the river broadens in some places to form such "lakes" as Lake St. Francis and Lake St. Louis. The upper St. Lawrence has about 48 kilometres of rap-



St.-John's-wort has colourful flowers and hardy foliage. People sometimes use this shrub as a border in gardens.

St. Lawrence River The St. Lawrence is the second longest river in Canada. Only the Mackenzie River is longer. The St. Lawrence flows about 1,300 kilometres from the northeast end of Lake Ontario to the Gulf of St. Lawrence. The river connects the Atlantic Ocean and the Great Lakes.



ids. It falls from 75 metres above sea level at Lake Ontario to 6 metres above sea level at Montreal.

The middle St. Lawrence extends from Montreal to Quebec City and is about as wide as the upper part of the river. It includes one "lake," Lake St. Peter.

The lower St. Lawrence is about 16 kilometres wide near Quebec City. It broadens to 145 kilometres at its mouth at the western tip of Anticosti Island in the Gulf of St. Lawrence. Every second, the river empties about 11,000 cubic metres of water into the gulf. The gulf is a deep arm of the Atlantic Ocean, and the tides of the ocean affect the river as far west as Trois-Rivières. The tides may raise the level of the river as much as 6 metres. East of Trois-Rivières, the ocean changes the water of the river from fresh to salty.

Commerce. The St. Lawrence carries more freight than any other river of Canada—over 54 million metric tons annually. About 40 per cent of this cargo moves between North America and countries overseas.

The freight carried on the St. Lawrence consists chiefly of *bulk cargo*. Such cargo includes grain, iron ore, and other goods that are stored loose in the holds of ships called *dry bulk carriers*. These ships carry iron ore from western Labrador in Quebec to the steel mills of Chicago, Cleveland, and other ports on the Great Lakes. The ships return with grain from lake ports. Iron ore accounts for about half the freight traffic up the river, and wheat and other grains make up about three-fourths of the downriver freight.

The lower St. Lawrence is more than 30 metres deep, but the river becomes much shallower upstream. Until 1959, parts of the upper St. Lawrence were too shallow for large ships to pass through. That year, the United States and Canada completed the St. Lawrence Seaway, which provided a navigation channel 8 metres deep. The seaway enabled most oceangoing vessels to sail between the Atlantic Ocean and such Great Lakes ports as Toronto; Thunder Bay, Ontario; Detroit; and Milwaukee.

The project also included construction of a hydroelectric power dam on the river near Cornwall, Ontario.

Animal and plant life. The St. Lawrence and its valley are the home of many kinds of animals and plants. Fishes of the river include bass, eels, perch, pike, smelts, and trout. Forests of birch, elm, hemlock, maple, oak, and spruce trees grow along the river's shores. The woods provide shelter for bears, deer, foxes, moose, muskrats, opossums, rabbits, raccoons, skunks, and squirrels. Such waterfowl as ducks, geese, gulls, and loons build their nests near the river.

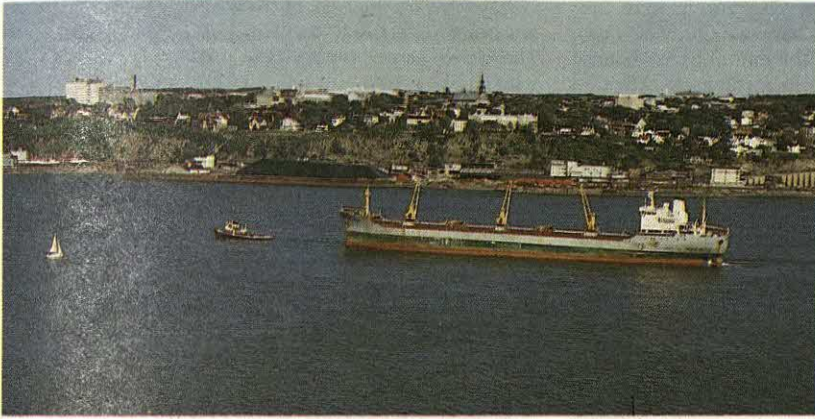
Pollution from factories, sewage, and ship wastes is the greatest threat to the river's wildlife. Canada and the United States have taken steps to control pollution from these sources.

History. The channel of the St. Lawrence was formed by the same glacier that carved out the Great Lakes. The glacier melted from 11,000 to 15,000 years ago, toward the end of the Pleistocene Ice Age. The resulting water created the lakes and the river.

Algonquin and Iroquois Indians lived along the St. Lawrence before Europeans arrived. The French explorer Jacques Cartier led an expedition up the river in 1535. On August 10, the feast day of Saint Lawrence, Cartier entered a bay that he named the Gulf of St. Lawrence. From there he sailed to what is now Montreal, where he was stopped by rapids. Cartier called the river the River of Canada, but it became known as the St. Lawrence about 100 years later.

During the 1600's, the French established settlements at Quebec City, Trois-Rivières, Montreal, and other points along the river. Many of these settlements became fur-trading centres and busy ports. The St. Lawrence also became part of a route to settlements in what is now the United States.

Great Britain won control of Canada from France at the end of the Seven Years' War (1756-1763). The St. Lawrence then became a main transportation route for the



The St. Lawrence River is an important commercial waterway in Canada. Ships carry more freight on the St. Lawrence than on any other Canadian river. Their cargo includes iron ore and wheat and other kinds of grain.

huge cargoes of furs, timber, wheat, and other Canadian exports shipped to Britain.

Various attempts were made to improve navigation on the St. Lawrence River. In 1680, construction of a canal was begun to enable traders and trappers to bypass the rapids near Montreal. Other canals were added through the years, and work on the St. Lawrence Seaway began in 1954. Each year, the upper St. Lawrence freezes for the winter. Canada and the United States are seeking ways to keep the river open throughout the year without harming the environment.

Related articles in *World Book* include:

Great Lakes

Thousand Islands

Gulf of Saint Lawrence

Saint Lawrence Seaway is a major commercial waterway that links the Atlantic Ocean and the Great Lakes in North America. The seaway is formed by the St. Lawrence River, several lakes, and a system of canals and locks. It includes a hydroelectric power project that supplies electricity to parts of Ontario and of New York.

The St. Lawrence Seaway handles about 45 million metric tons of cargo annually. Most of the freight travels from Canada and the United States to countries in Europe. The freight consists mainly of *bulk cargo*, such as grain, minerals, and other raw products. The seaway is the cheapest shipping route for large quantities of these products. Iron ore and wheat, which are bulk cargoes, make up about 50 per cent of the tonnage. Other freight carried on the seaway includes coal, oil, and *general cargo*, which consists of such manufactured products as automobiles and steel.

Canadian ships carry about 65 per cent of the seaway trade. The United States and other nations transport the rest.

The Atlantic Ocean and the Great Lakes have different elevations, but canals and locks enable ships to navigate the seaway. Most of the canals and locks are on the St. Lawrence River between Montreal and Lake Ontario. The rest form the Welland Canal, which connects Lakes Ontario and Erie. Lake Ontario, the lowest of the Great Lakes, is more than 60 metres higher than the ocean.

Canada and the United States began to build the St. Lawrence Seaway in 1954 and completed it in 1959. Each nation built and operates its own section of the waterway. The seaway plays an important part in the economies of both countries.

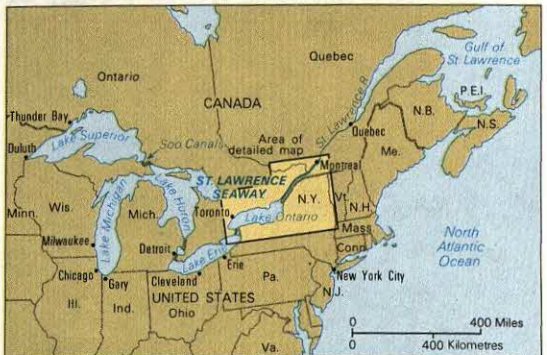
The seaway system

The St. Lawrence Seaway extends about 725 kilometres from the eastern end of Lake Erie to Montreal. Major Canadian ports served by the waterway include, from east to west, Montreal, Toronto, Hamilton, and Thunder Bay. Among the chief U.S. ports that handle seaway shipping are Buffalo, Detroit, and Chicago.

Canals and locks of the waterway are operated by the St. Lawrence Seaway Authority in Canada, and by the St. Lawrence Seaway Development Corporation in the United States. The Canadian agency administers about 89 kilometres of canals and 13 locks. Five of the locks are between Montreal and Lake Ontario, and the rest make up the Welland Canal. The U.S. agency runs about 16 kilometres of canals, plus two locks near Massena, New York. The agencies jointly set tolls.

All the seaway's canals are at least 60 metres wide and 8 metres deep. The locks measure 24 metres wide, 233 metres long, and 9 metres deep. A ship passes through one of the locks in about 35 minutes.

The seaway is open from early April to December. In good weather, a ship can travel the entire route in about 1½ days. However, fog and high winds sometimes delay traffic. Also, ships are often delayed by the Welland Canal, which was not designed to handle the growing number of vessels that use the seaway.



The St. Lawrence Seaway lies in Canada and the United States. The two nations developed it to provide large ships with a water route linking the Great Lakes and the Atlantic Ocean.

The hydroelectric power project along the seaway is at the Moses-Saunders Dam, between Cornwall, Ontario, and Massena, New York. The dam supplies about 1,600,000 kilowatts of electricity to sections of Ontario and New York. It is managed jointly by the Hydro Electric Power Commission of Ontario and the New York Power Authority.

Lake St. Lawrence, which provides the water used by the power project, is more than 48 kilometres long. The lake once included an area of rapids. The three dams that form the lake eliminated the rapids.

Saint Lazarus, Order of, is a Christian religious organization of knights and nurses founded in Jerusalem about 1120. Its official name was the Military and Hospitaller Order of St. Lazarus of Jerusalem. The order was established to operate hospitals, especially for lepers; to assist pilgrims; and to spread the Christian faith. In 1253, the order transferred its activities to Europe. It continues today as an honorary organization based in Paris.

Saint Leger, Barry (1737-1789), a British soldier, fought against the Americans in the American Revolution. St. Leger's retreat to Canada after the Battle of Oriskany in 1777 was instrumental in upsetting the British campaign plan, and contributed to Burgoyne's surrender at Saratoga (see **Burgoyne, John**). St. Leger also fought in the Seven Years' War.

Saint Louis (pop. 396,685) is the second largest city in the state of Missouri, U.S.A., and a leading industrial and transportation centre of the United States. Only Kansas City has more people. Saint Louis lies on the west bank of the Mississippi River, about 16 kilometres south of the place where the Mississippi meets the Missouri River. St. Louis is the busiest inland port on the Mississippi River.

In 1764, French fur traders built a post on the site of

what is now St. Louis. They chose the site because Indians bringing furs to trade could reach it easily by canoe. The French named the settlement after King Louis IX, who had been made a saint. It came under U.S. control when President Thomas Jefferson bought the Louisiana Territory from France in 1803.

During the first half of the 1800's, St. Louis served as a gateway to the West and as a main port for Mississippi River steamboats. The city became a rail centre after the American Civil War (1861-1865). During the late 1800's, industrial expansion helped St. Louis become one of the nation's chief urban centres.

More than 97 per cent of the people of St. Louis were born in the United States. The city includes many people of African, English, French, German, Irish, Italian, Polish, and Scottish descent.

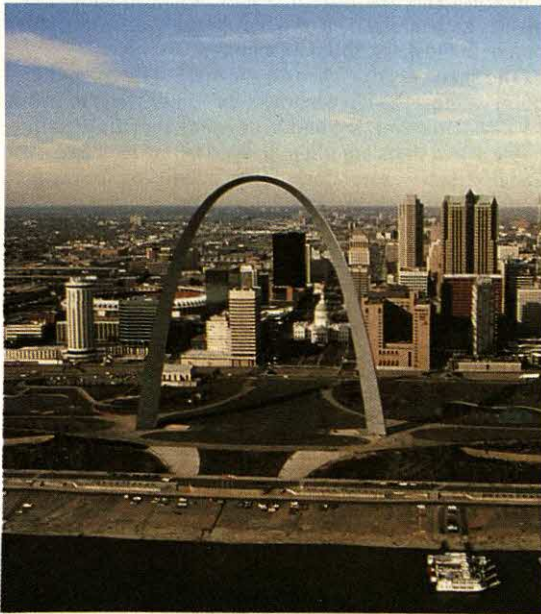
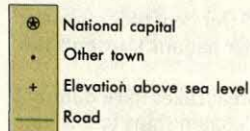
Blacks make up about half of the city's population. The population of northern St. Louis, which has the city's worst slums, is largely black. Most of the people of the southern half of the city are white. Despite public housing projects, living conditions in the black community remain a major problem.

The more than 3,000 manufacturing plants in metropolitan St. Louis produce over 28 billion U.S. dollars worth of goods yearly. Approximately a quarter of the area's workers are employed in industry. The production of transportation equipment is the city's leading manufacturing activity, and St. Louis ranks high in car production. Since the 1950's, a number of industries have moved to the suburbs, and new office buildings have been built in the city centre.

Missouri and Osage Indians lived in the St. Louis region when French explorers arrived in the mid-1600's. In 1763, a French fur trader, Pierre Laclède Liguist, and his stepson, René Auguste Chouteau, visited the site of what is now St. Louis. The next year, they established a settlement there and opened a trading post. The settlement became a key point in the westward expansion of the United States.

St. Louis was incorporated as a town in 1809. In 1822, when it became a city, St. Louis had a population of about 5,000. During the mid-1800's, large numbers of German and Irish workers settled in the city. By 1870, St. Louis had 310,864 people and ranked as the third largest U.S. city behind New York City and Philadelphia.

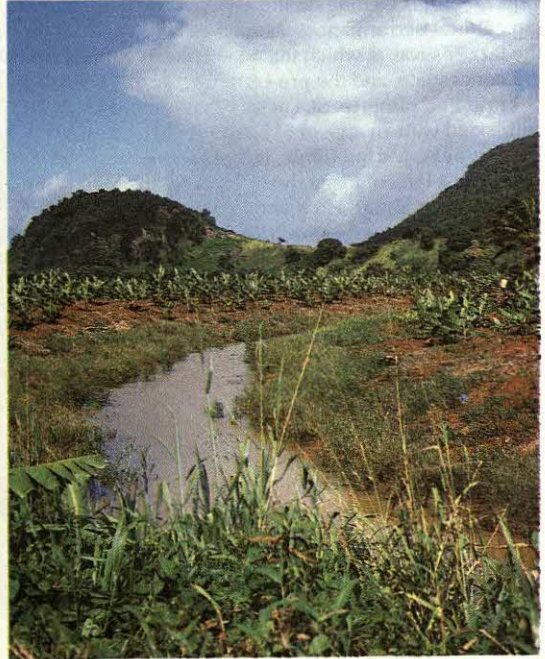
St. Lucia



The Gateway Arch, in St. Louis, was designed by the architect Eero Saarinen. At 192 metres high, it is the tallest monument in the United States.



Sulphur Springs rise from a low-lying volcanic crater at Soufrière, St. Lucia.



Banana plantations make an important contribution to the economy of St. Lucia.

Saint Lucia is an independent island country in the eastern Caribbean Sea. It lies between Martinique and Saint Vincent, about 386 kilometres north of Venezuela. St. Lucia is one of the Windward Islands, a chain within the larger archipelago of the Lesser Antilles in the West Indies. Its capital, Castries, is located on the northwest coast (see **Castries, Windward Islands**). The island is the birthplace of two West Indian Nobel Prize winners. Sir Arthur Lewis was awarded the Nobel Prize for economics in 1979, and Derek Walcott received the Nobel Prize for literature in 1992.

Government. St. Lucia is a constitutional monarchy with a ceremonial governor general who represents the United Kingdom monarch as head of state. The country has a *bicameral* (two-chamber) parliament made up of a 17-member House of Assembly (the lower house) and an 11-member Senate. The members of the House of Assembly are elected by the people. Elections are held every five years. In the Senate, six members are appointed on the advice of the prime minister, three on the advice of the leader of the opposition, and two by the governor general. St. Lucia's judicial system consists of a supreme court made up of a court of appeal and a high court.

People. For St. Lucia's total population, see the *Facts in brief* table with this article. Most St. Lucians are of African origin, descended from slaves imported between the 1600's and the 1800's. There are also some East Indians and people of mixed ethnic origins.

Religion. About 85 per cent of St. Lucians are Roman Catholics. The rest are members of the Anglican, Methodist, Baptist, and other churches.

Education. Education is free and compulsory for chil-

dren of primary school age. Most children begin their education at places called preschools. There are 83 primary schools, 13 secondary schools, and one tertiary level institution, the Sir Arthur Lewis Community College, located in Castries. A branch of the University of the West Indies (UWI) School for Continuing Studies is located at Morne Fortune.

Language. The official language of St. Lucia is English, but a large proportion of the people regularly use a French *patois* (dialect). The French cultural influence on the island is the result of frequent occupation by French forces during the 1600's and 1700's. Place names such as Gros Islet, Vieux Fort, Choiseul, and Soufrière also show this French influence.

Way of life. About 55 per cent of St. Lucia's population live in rural areas. The rest live in urban communities. Many people live in pastel-coloured wooden houses. Nearly a quarter of St. Lucia's working people make a living from agriculture. Growing bananas and other fruit is the main occupation for St. Lucia's farming community, but some earn their living by woodland management or by fishing. Most of St. Lucia's other workers find jobs in hotels, restaurants, and businesses connected with tourism.

Clothes. St. Lucians wear Westernized clothing. However, women wear a distinct and brightly coloured national costume during cultural presentations and independence anniversary celebrations. The costume consists of a colourful dress which fits the contours of the body down to the waist and widens at the skirt. It is pinned up at points to display a white petticoat trimmed with lace. Accessories consist of a headband, scarf, and large round earrings.

Recreations include dining and dancing, and attending cultural performances. Annual celebrations include the Jazz Festival, at which the world's leading performers congregate, and the pre-Lenten carnival.

Land and climate. St. Lucia is a volcanic, mountainous island with an area of 616 square kilometres. Its highest peak, Morne Gimie, is 959 metres above sea level. It is a land of many rivers, inactive volcanoes, and fertile valleys. Grand Piton and Petit Piton are volcanic peaks near the town of Soufrière. This town also has what is said to be the world's only drive-in volcano, a low-lying volcanic crater that spews bubbling, hot sulphur springs.

St. Lucia's average year-round temperature is 26 °C. Its rainy season lasts from June to November. The annual rainfall averages 130 centimetres in the coastal regions and nearly 300 centimetres in the interior.

Economy. Service industries—made up of hotels and restaurants, government services, the distributive trades, and tourism—employ more than half of St. Lucia's working population and contribute 72 per cent of its *gross domestic product* (GDP, the total value of all the goods and services produced within a country during one year). Agriculture today is less important than it used to be but still supplies about 12 per cent of GDP and employs 25 per cent of the island's workers. Manufacturing, chiefly the processing of agricultural products, and the production of packaging and clothing, accounts for about 7 per cent of GDP and employs 14 per cent of the workforce.

Bananas dominate the agricultural sector of St. Lucia's economy and are the island's chief export. Other exports include beer, cardboard boxes, clothing, and refined coconut oil. St. Lucia's chief trading partners are the United Kingdom and other members of the European Union, the United States, and Caribbean islands belonging to the Caribbean Community (CARICOM).

History. The first settlers of St. Lucia were the Arawak, who arrived about A.D. 200. These peaceable people were later overpowered by an aggressive group called the Carib about A.D. 800. The Caribs occupied St. Lucia for hundreds of years. Historians are not certain which European explorer first sighted the island or when. However, it was certainly named St. Lucia after a



Castries Port, above, is the major port in St. Lucia. Castries is the island's capital.

Spanish saint who died about A.D. 304. The hostility of the Carib thwarted early efforts by European colonists to settle the island. French colonists from Martinique established the first permanent settlement on the island in 1650. The colonists made a pact with the Carib 10 years later. In 1664, Thomas Warner captured the island for the British.

During the 1600's and early 1700's, the French and British fought for possession of the island, causing it to change hands 14 times. St. Lucia was finally ceded to the British in 1814. After the abolition of slavery in 1838, St. Lucia was incorporated into the Windward Islands Administration.

In 1958, St. Lucia became a member of the West Indies Federation. It became a separate unit in 1962, won internal self-government in 1967, and became fully independent in 1979.

John Compton, leader of the United Workers' Party (UWP), led the country to independence in 1979. He lost power later that same year, defeated by the St. Lucia Labour Party. Internal friction led to the premature collapse of the St. Lucia Labour Party government and to its replacement by an interim government, which oversaw the 1982 elections. The UWP under Compton was elected to office and governed uninterrupted into the mid-1990's.

See also **Arawak Indians; Carib Indians; Commonwealth of Nations; Grenada (History).**

Saint Mark, Basilica of, is the Roman Catholic cathedral of Venice, Italy. It is also called the Cathedral of St. Mark. The basilica is named after Saint Mark, the patron saint of Venice.

The basilica is built primarily in the Byzantine style, though its architecture also reflects Romanesque and Gothic influences. The building is constructed in the shape of a Greek cross, which has four arms of equal length. The church is 76.5 metres long, and it is 62.5 me-

Facts in brief about Saint Lucia

Capital: Castries.

Official language: English.

Official name: Saint Lucia.

Area: 616 km². *Greatest distances*—north-south, 43.2 km; east-west, 22.4 km. *Coastline*—158 km.

Elevation: *Highest*—Mount Gimie, 959 m above sea level.

Population: *Estimated 1996 population*—144,000; density, 221 people per km²; distribution, 45 per cent urban, 55 per cent rural. *1992 census*—138,151. *Estimated 2001 population*—154,000.

Chief products: *Agriculture*—bananas, coconuts, cocoa, copra, mangoes, root crops, vegetables. *Manufacturing*—clothing, electrical parts, assembly products, paper products, textiles.

National anthem: Untitled.

Money: *Currency unit*—East Caribbean dollar. One dollar = 100 cents.



St. Michael's Mount lies off the Cornwall coast in south-western England. A causeway links the islet to the mainland at low tide.

tres wide at its widest point. A dome rises over each arm and over the place where the arms meet. A separate *campanile* (bell tower) stands near the basilica in St. Mark's Square.

The present church is the third on the site. It was built as the palace chapel for the *doge* (ruler) of Venice, and was consecrated in 1073. It was designated a cathedral in 1807. Its interior is richly decorated with mosaics, carvings, and coloured marble. Many of these works of art were brought from the Byzantine capital of Constantinople (now Istanbul) by Christian warriors fighting the Fourth Crusade about 1204. The crusaders also brought four bronze horses that stand over the basilica's entrance and many precious objects now in its treasury.

See also **Campanile; Venice** (picture); **World, History of the** (picture: The Basilica of St. Mark).

Saint Martin, also called *Sint Maarten* in Dutch, is an island in the Caribbean Sea at the northern end of the Windward Islands (see **Windward Islands**). The island is about 34 square kilometres in area. The northern part, accounting for just over two-thirds of the whole island, is controlled by France. It forms part of the French overseas department of Guadeloupe (see **Guadeloupe**). Its capital is Marigot. The southern part is controlled by the Netherlands and is part of the northern (Windward Islands) group of the Netherlands Antilles (see **Netherlands Antilles; Windward Islands**). Its capital is Philipsburg.

Nearly 32,000 people inhabit the island of St. Martin. Most are of African origin, the descendants of slaves taken there in the 1600's to work sugar-cane plantations. Tourism is the mainstay of the economy.

Christopher Columbus discovered the island of St. Martin on November 11, 1493 (see **Columbus, Christopher**). The island was highly prized for its natural salt-bearing lakes. It changed hands many times between the Spanish, Dutch, and French. Eventually, in 1648, the French and Dutch agreed to share the territory.

Saint Michael's Mount is a picturesque rocky islet in Mount's Bay, off Cornwall, England. It lies about 5 kilometres east of Penzance and 1.25 kilometres from Marazion on the mainland, from which it can be reached by a narrow causeway at low tide. A castle on the summit of the islet has a chapel, built in the 1300's. Below the castle lies a small village with a harbour.

Saint Mihiel. See **Air force** (Famous air battles).

Saint Moritz (pop. 5,263) is a famous resort town in the Alps of eastern Switzerland. It lies 1,840 metres above sea level in the Engadin Valley of the *canton* (state) of Graubünden. It stands between mountain slopes and along a small lake. For location, see **Switzerland** (map).

The economy of St. Moritz is based on tourism. Visitors enjoy the area's scenic beauty, clean air and sunshine, big hotels and restaurants, and varied recreational facilities. Favourite activities there include skiing, ice skating, sailing, swimming, and hiking.

Roman soldiers built a settlement on the site of St. Moritz in the 50's B.C. The town became a major tourist resort in the 1800's. It was the site of the Winter Olympics in 1928 and 1948. The people of St. Moritz speak Romansh, a language used by only about 60,000 people in the valleys of Graubünden canton.

Saint Nicholas, Feast of, is a children's festival celebrated on December 6, the feast day of Saint Nicholas. The saint was a bishop in Asia Minor during the A.D. 300's. He has been the patron saint of children since the Middle Ages. The festival is observed primarily in Europe. In some countries, children fill their shoes with straw and carrots for Saint Nicholas' horse on the night of December 5. In the morning, they find the straw and carrots replaced by small toys and biscuits. But if children have been naughty, they receive a whipping rod.

The Dutch took the festival to America during the 1600's. In the 1800's, the figure of Saint Nicholas was changed into Santa Claus. However, St. Nicholas Day

continued to be observed in many communities well into the 1900's.

See also **Christmas** (Gift giving); **Nicholas, Saint**; **Santa Claus**.

Saint Patrick's cross. See **Flag** (pictures: Historical flags of the world [Crosses in the British flag]).

Saint Patrick's Day is celebrated on March 17, the feast day of Saint Patrick, the patron saint of Ireland. Saint Patrick was a missionary to Ireland in the A.D. 400's who converted the Irish to Christianity. St. Patrick's Day is a national holiday in Ireland. It also is celebrated outside of Ireland in cities with people of Irish descent.

In Ireland, St. Patrick's Day is primarily a religious holiday. People honour Saint Patrick by attending special religious services, enjoying family and community gatherings, and wearing shamrocks. According to legend, Saint Patrick used a shamrock to explain the idea of the Trinity to the Irish (see **Shamrock**).

See also **Patrick, Saint**.

Saint Paul's Cathedral. See **London** (Churches; picture: Places to visit in London).

Saint Peter's Church, also called St. Peter's Basilica, in Vatican City, is Europe's largest Christian church. It is the second church to stand above the *crypt* (tomb) believed to hold the body of Saint Peter, the first pope.

St. Peter's is built in the shape of a cross. The church is almost 210 metres long and about 135 metres across at its widest point. It covers more than 15,100 square metres. The *nave* (centre aisle) is about 45 metres high. The building's most outstanding architectural feature is its magnificent dome, designed by Michelangelo. The dome rises more than 120 metres from the floor, and measures 42 metres in diameter.

The exterior. The church was given an impressive setting by Gian Lorenzo Bernini, one of its architects. An avenue almost 1.5 kilometres long leads from the Tiber River to the *Piazza di San Pietro* (Square of St. Peter), a large open space in front of the church. The piazza, which was completed in 1667, contains two fountains and two *colonnades* (rows of columns) arranged in semicircles on opposite sides of the piazza. A red granite *obelisk* (shaft) stands 26 metres high in the piazza's

centre. It was brought to Rome from Egypt about A.D. 37, and was moved to the piazza in 1586.

The interior of the church is decorated in baroque style. Bernini, who was also a sculptor, created many of its famous features in the 1650's. He built the elaborate bronze *baldacchino* (canopy) over the main altar, which stands beneath the dome. He also designed papal tombs and monuments for the church. Marble, gilding, and mosaics decorate the walls and ceiling. Chapels, altars, and tombs line the walls. Michelangelo's famous sculpture, the *Pietà*, stands in one of the chapels.

History. The first St. Peter's Church was begun by Constantine the Great about 325. He built the church to celebrate his acceptance of Christianity.

The church was modelled on the *basilica*, a rectangular building used as a meeting hall by the Romans (see **Basilica**). Four rows of columns, extending almost the length of the church, divided it into a nave with two aisles on either side.

Throughout the Middle Ages, many people made pilgrimages to the church. In 1452, Pope Nicholas V began to restore and expand St. Peter's. The restoration continued until 1506, when Pope Julius II decided to rebuild the church completely.

During its construction, 10 different architects worked on St. Peter's and changed its design. The first architect was Donato Bramante. He designed a domed, perfectly symmetrical church in the form of a *Greek cross* (a cross with four arms of equal length). Other famous architects of St. Peter's included Michelangelo, Giacomo della Porta, and Carlo Maderno. Michelangelo changed Bramante's plan for a balanced and restful dome into a dynamic construction. He put a *drum* (ring) at the base of the dome that appears to be squeezing the dome and forcing its sides to spring upwards. Giacomo della Porta continued Michelangelo's dynamic plan and completed the dome in 1590. During the early 1600's, Carlo Maderno lengthened the nave, so that the church took the form of a *Latin cross* (a cross with a short horizontal bar crossing a longer vertical bar above the centre). Maderno also designed the church's massive *facade* (front).



St. Peter's Church in Vatican City stands over the tomb believed to contain Saint Peter's body. The church, built in the shape of a cross, can hold more than 50,000 people. A large *piazza* (square) lies in front of the basilica.

The building was dedicated in 1626 by Pope Urban VIII, but other parts were added to the structure later.

Related articles in *World Book* include:

Architecture (Later Renaissance) Rome (picture: An air view of Bernini, Gian Lorenzo Rome; Churches, palaces, Italy (Arts [with picture]) and fountains) Michelangelo Vatican City (with picture)

Saint Petersburg (pop. 4,468,000; met. area pop. 5,020,000), formerly Leningrad, is the second largest city in Russia. Only Moscow, the capital, has more people. St. Petersburg is a major Russian port and one of the world's leading industrial and cultural centres. The city lies in northwestern Russia. For location, see **Russia** (political map).

St. Petersburg was the first Russian city built in imitation of western European cities. Its magnificent palaces, handsome public buildings, and wide public squares resemble those of London, Paris, and Vienna. In the early 1800's, a planning commission that included the noted Italian architect Carlo Rossi established a design for the centre of the city with a series of squares.

The city has had three names. Czar Peter I (the Great) founded it in 1703 as St. Petersburg. After Russia went to war against Germany in 1914, at the start of World War I, the name was changed to Petrograd. The country's officials chose this name, which means *Peter's City* in Russian, to get rid of the German ending *burg*. In 1922, the Soviet Union was formed under the leadership of Russia. In 1924, the Soviet Union's Communist government renamed the city in honour of V. I. Lenin, the founder of the Soviet Communist Party. In 1991, the people of the city voted in a nonbinding referendum to restore the name St. Petersburg. In September 1991, the Soviet government officially approved the name change. In December 1991, the Soviet Union was dissolved, and Russia became an independent nation.

The city lies on a marshy lowland where the Neva River empties into the Gulf of Finland, at about 60° north latitude. Because of its far northern location, St. Petersburg has very short periods of daylight in winter. For

about three weeks in June, it has "white nights," during which the sky is never completely dark.

The centre of St. Petersburg is on the southern bank of the Neva. Many fine examples of baroque and neo-classical architecture have been preserved in the area, and few modern structures have been built there.

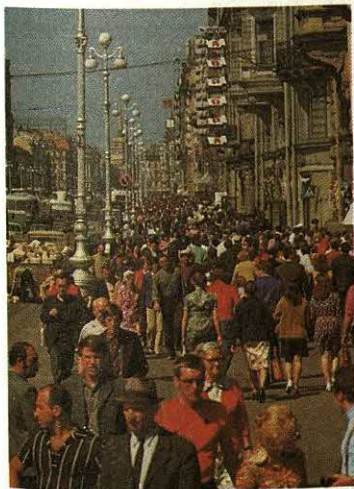
The historic Winter Palace (now the Hermitage Museum), completed in 1762, stands in the centre of the city. Several hundred metres away is the Cathedral of St. Isaac of Dalmatia, whose massive golden dome dominates St. Petersburg's skyline. The Peter and Paul Fortress, begun in 1703, is the oldest building in St. Petersburg. Many Russian czars are buried in a cathedral at the fortress.

The centre of St. Petersburg is surrounded by old residential areas. Near the outskirts of the city are thousands of modern blocks of flats. The western section of St. Petersburg is the chief industrial district of the city.

Several luxurious palaces built in the 1700's still stand in three suburbs of St. Petersburg—Pavlovsk, Petrodvorets, and Pushkin. These palaces, famed for their architectural excellence, were summer homes of the czars.

Education and cultural life. Over 40 institutions of higher learning are in St. Petersburg. The Conservatory of Music, established in 1862, is the nation's oldest music school. Its graduates include such famous composers as Sergei Prokofiev, Dimitri Shostakovich, and Peter Ilich Tchaikovsky. The Choreographic School trained such famous ballet dancers as Vaslav Nijinsky, Rudolf Nureyev, and Anna Pavlova.

St. Petersburg is the home of many fine museums and theatres. The Hermitage is known throughout the world for its masterpieces. It exhibits outstanding collections of ancient Greek and Roman sculpture; Islamic art; and Baroque, Renaissance, and French impressionist paintings. The Russian Museum has a large collection of Russian art. The Kirov Theatre presents ballet and opera. Dramatic productions are offered by several theatres, including the Gorki Academic Theatre, the Pushkin Theatre, and the Young Spectators' Theatre.



Huge crowds jam St. Petersburg's main street, Nevsky Prospekt. Many fine restaurants and shops line the street.



A luxurious palace built during the 1700's still stands in Petrodvorets, a suburb of St. Petersburg. Hundreds of fountains adorn the grounds of the palace, which was the summer residence of several Russian czars.

The city has an important place in Russian literature. A number of famous Russian authors have used St. Petersburg as a background for many of their works. These writers include Alexander Pushkin, Fyodor Dostoevsky, and Andrey Bely.

People. Most of St. Petersburg's people are members of the Russian nationality, or ethnic group. Jews and Ukrainians are the largest minority groups.

Many St. Petersburgers live in old blocks of flats in the mid-city area. Most of the flats on the outskirts of St. Petersburg are less crowded than those of the inner city. But many people prefer to live in the centre of the city, with its shops, museums, theatres, and other attractions.

Few St. Petersburgers own cars, but the city has an efficient public transportation system of buses, trams, and underground trains. Like other cities, St. Petersburg has such problems as air pollution and overcrowding.

Economy. The city has been a major shipbuilding centre since the early 1700s. During the 1800s, it became an important manufacturer of machine tools. Today, the production of machinery makes up about 40 per cent of the city's industry. Other important products include chemicals, electrical equipment, textiles, and timber.

St. Petersburg's industry and location make it an important trade and distribution centre. The city has an excellent port and is served by 12 railways.

History. Peter the Great founded the city as St. Petersburg in 1703. He had visited western Europe and wanted to bring Western culture and technology to Russia. He made St. Petersburg his "window to the West," a showcase for his efforts to westernize Russian life. Western architects played an important role in the city's construction. In 1712, Peter moved the nation's capital from Moscow to St. Petersburg. The new capital soon became the intellectual and social centre of the Russian Empire. By 1800, over 220,000 people lived in the city.

The city played an important part in many major events in Russian history. In 1825, an unsuccessful uprising against Czar Nicholas I took place there. In 1881, a group of Russian revolutionaries assassinated Czar Alexander II in St. Petersburg. Early in 1905, troops of Czar Nicholas II killed or wounded hundreds of unarmed demonstrators in front of the Winter Palace. This *Bloody Sunday* slaughter led to the Revolution of 1905.

The city's name was changed to Petrograd in 1914. Riots and strikes occurred during the Revolution of 1917, which ended czarist rule in the country. Late that year, Bolshevik (Communist) forces seized the city and formed a new government, headed by Lenin. The Bolsheviks moved the capital back to Moscow in 1918. Petrograd was renamed Leningrad upon Lenin's death in 1924.

In 1934, a Communist Party leader named Sergey Kirov was assassinated in Leningrad. His murder touched off the *Great Purge*, during which the government's secret police killed or imprisoned millions of people. During World War II (1939-1945), Leningrad was a major target of Germany's attack on the Soviet Union. The Germans laid siege to the city from September 1941 to January 1944. About a million citizens died during the siege, most of them from starvation. The city was badly damaged by the attack but it did not fall.

A large number of the city's historic structures were

rebuilt after World War II. The city also carried out construction projects to overcome a severe housing shortage. More than 600,000 flats were provided in buildings that went up from 1961 to 1973. In 1966, city officials adopted a long-range programme aimed at achieving a more satisfactory distribution of housing, office buildings, and parks.

In the late 1980s, the Communist Party's tight control of the Soviet Union began to break up. As a result of elections held in 1990, non-Communists won control of Leningrad's government. In August 1991, conservative Communist officials attempted to take over the Soviet central government. More than 130,000 people turned out in Leningrad to demonstrate their opposition to the coup. The coup failed within days, unleashing anti-Communist sentiments throughout the nation. In September 1991, the city's Communist name of Leningrad was changed back to the original St. Petersburg.

Saint-Pierre and Miquelon are two French islands about 16 kilometres south of Newfoundland. The islands cover a total area of 242 square kilometres, and have a population of about 6,000. The two islands and several small islet dependencies make up a political unit of France called a territorial collectivity.

The rocky islands are important as a base for French fishing operations. They also draw many tourists during the summer. St-Pierre is the capital and largest town.

France first occupied the islands in 1635. England and France controlled them in turn until 1814, when France took final possession. In 1956, the French government gave them self-government.

Saint-Saëns, Camille (1835-1921), was a French composer. His most famous work is *The Carnival of the Animals* (1886) for two pianos and orchestra. His other major compositions include the Cello Concerto No. 1 (1873), the Piano Concerto No. 4 (1875), the opera *Samson and Delilah* (1877), and the chamber work *Septet* (1880).

Charles Camille Saint-Saëns was born in Paris. He was a child prodigy, composing several pieces for piano by the age of 5 and making his debut as a pianist at the age of 10. In 1871, he helped found the Société Nationale de Musique to encourage new French music. Under his leadership, the Société introduced the works of such French composers as Claude Debussy, Vincent d'Indy, Gabriel Fauré, and César Franck. Saint-Saëns was also an accomplished pianist and organist.

Saint-Simon, Comte de (1760-1825), was a founder of French socialism. His ambition was to better humanity. He wanted to bring about a new society in which all people would have to work and would receive rewards equal to their labour. No person would be allowed to inherit wealth, and all individuals would start life on an equal basis. Saint-Simon wanted to base his social theories on scientific evidence, but actually his conclusions were unsystematic.

Saint-Simon was born in Paris. Saint-Simon took no active part in the French Revolution, though he welcomed it. He was born Claude Henri de Rouvroy.

Saint Sophia. See Hagia Sophia.

Saint Swithin's Day, the feast day of St. Swithin, is held in England on July 15. Swithin, also spelt *Swithun*, was bishop of Winchester and the trusted adviser of Ethelwulf, king of the West Saxons. Ethelwulf made him

bishop about 852. St. Swithin's name is commemorated by this rhyme:

St. Swithin's day if thou dost rain,
For forty days it will remain;
St. Swithin's day if thou be fair,
For forty days 'twill rain nae fair.

Saint Thomas. See Virgin Islands of the United States.

Saint Valentine's Day. See Valentine's Day.

Saint Vincent and the Grenadines is an independent country in the West Indies. It consists of 32 islands and numerous *cays* (low sand banks) in the eastern Caribbean Sea. The largest island is St. Vincent. The others belong to the Grenadines, a chain of about 800 islets extending between St. Vincent and Grenada. The country's capital, Kingstown, is located in the southern section of St. Vincent (see **Kingstown**).

The island chain forms part of the Windward Islands, part of the Lesser Antilles (see **Windward Islands**). It lies about 320 kilometres north of Venezuela, 160 kilometres west of Barbados, 121 kilometres north of Grenada, and 34 kilometres south of St. Lucia.

Eight of the islands that make up the territory of St. Vincent and the Grenadines are inhabited. They are St. Vincent, Bequia, Mustique, Canouan, Mayreau, Union Island, Palm Island, and Petit St. Vincent. The Grenadine Islands are largely scenic tourist attractions. Mustique is famous as a holiday home for film stars and other celebrities.

Government. St. Vincent and the Grenadines is a constitutional monarchy. A governor general is the head of state and represents the monarch of the United Kingdom. A prime minister, head of the majority political party in parliament, runs the government with the assistance of a *cabinet* (group of chosen ministers). Laws are passed by a *unicameral* (single-chamber) parliament called the House of Assembly. This consists of 15 elected members and 6 appointed members.

People. For the total population of St. Vincent and the Grenadines, see the *Facts in brief* table with this article. Nearly 25 per cent of the population live in Kingstown, the capital, and its suburbs. Another 19 per cent live in Calliaqua.

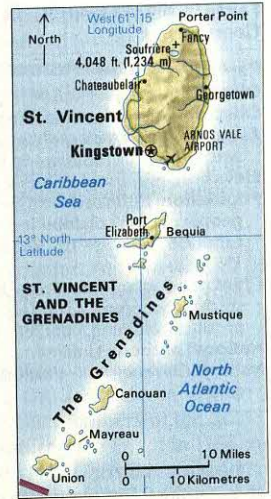
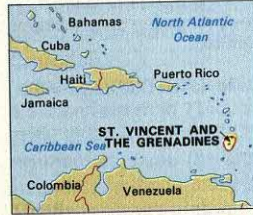
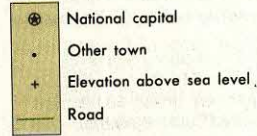
More than 77 per cent of *Vincentians* (citizens of St. Vincent and the Grenadines) are of African descent. About 3 per cent are descended from the islands' earlier Carib settlers, 1.4 per cent are East Indian, and 16.4 per cent are of mixed ethnic origins. Just under 1 per cent are of European ancestry. The official language of St. Vincent and the Grenadines is English, but many people also speak French.

Religion. The main religious denominations are Anglican, Methodist, Pentecostal, Baptist, and Roman Catholic. During the 1980's, the established churches lost members to the Baptists and Pentecostals.

Education. Education is provided mainly at preschool, primary, and secondary levels. It is provided free to children between the ages of 5 and 15. Most secondary schools are run by religious organizations.

Way of life. The culture and customs of St. Vincent and the Grenadines are a blend of Carib and African traditions. One local superstition is a belief in night spirits known as "jumbies".

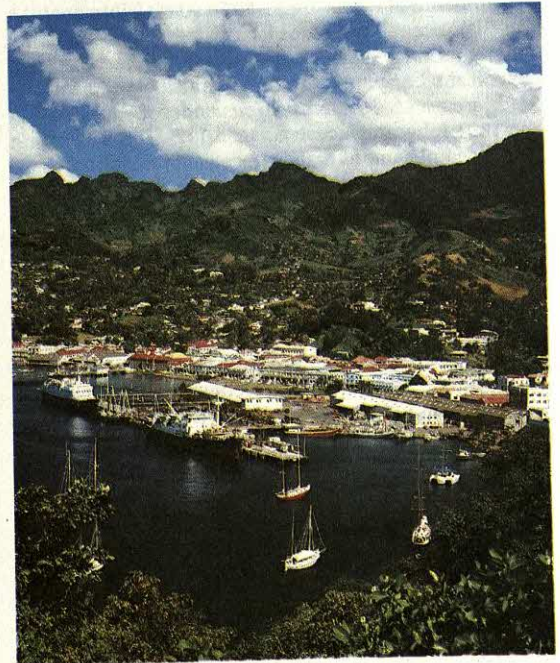
St. Vincent and the Grenadines



Most Vincentians work the land. Some are employed in service industries, and a few work in manufacturing.

Houses. Vincentian homes vary from modern concrete structures to traditional chattel and board and shingle houses of the 1800's. Wattle-and-daub huts, of Carib and African origin, still exist in the more remote villages of St. Vincent. Georgetown features the ruins of impressively large homes once owned by sugar planters. St. Vincent is also noted for its Georgian architecture.

Food and clothing. Bananas, fish, and rice are the chief foods. A favourite dish is made from baked breadfruit and fried fish. Most Vincentians wear Western-



St. Vincent and the Grenadines is a country in the Caribbean Sea. Its capital, Kingstown, has a beautiful harbour, *above*.

Facts in brief about Saint Vincent and the Grenadines

Capital: Kingstown.

Official language: English.

Official name: Saint Vincent and the Grenadines.

Area: 388 km². *Greatest distances*—north-south, 28.8 km; east-west, 17.6 km. *Coastline*—84 km.

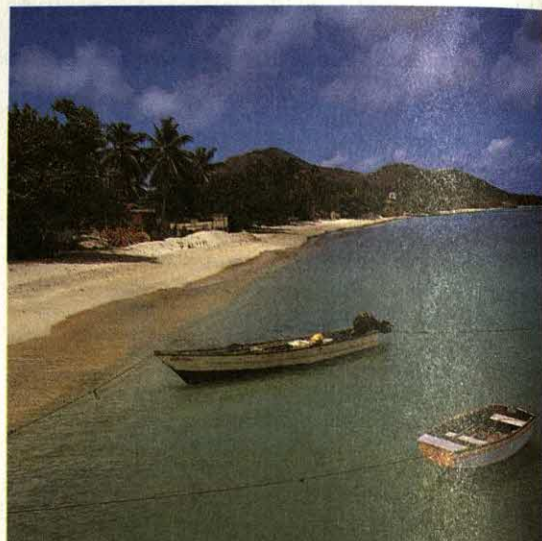
Elevation: *Highest*—Le Soufrière, 1,234 m above sea level.

Population: *Estimated 1996 population*—113,000; density, 278 people per km²; distribution, 40 per cent urban, 60 per cent rural. *1991 census*—107,598. *Estimated 2001 population*—118,000.

Chief products: *Agriculture*—bananas, coconuts, arrowroot, spices, root crops. *Manufacturing*—processing of agricultural products, clothing, concrete, furniture.

National anthem: Untitled.

Money: *Currency unit*—East Caribbean dollar. One dollar = 100 cents.



The Grenadines have beautiful white sand beaches and green hills. Hillsborough, *above*, is the capital of Carriacou.

style clothes, but elaborate costumes are worn at spectacular cultural events.

Recreation. Vincentians enjoy sporting and cultural activities. Annual events include the New Year celebration in January, the Union Island Big Drum Festival in February, the Union Island Easter Sports and Games, and the National Fishing Competition in May. Other annual celebrations are Carnival Week in July (famous for its Carnival Queen contest and calypso show), the Independence Celebrations that take place during October, the National Drama Festival, also in October, and the Christmas festivities.

Land and climate. St. Vincent and the Grenadines occupy a total area of 388 square kilometres. The main island, St. Vincent, is 345 square kilometres in area. The smallest inhabited islands are Palm Island and Petit St. Vincent, both of which are just 0.5 square kilometre in size. St. Vincent is noted for its lush vegetation and forests, rivers, and volcanic mountains. Its highest peak is the volcano Le Soufrière, 1,234 metres high. Le Soufrière erupted with disastrous consequences in 1821 and 1902. It became active again in 1979. The Grenadines have become famous mainly because of their fine beaches. St. Vincent's forested interior is home to many varieties of flora and the St. Vincent parrot, the country's national bird.

The climate is tropical, with temperatures ranging between 18 and 32 °C. The rainy season is usually from May to November.

Economy. The economy of St. Vincent and the Grenadines is based on agriculture, the largest provider of employment. Agricultural exports are among the chief earners of foreign exchange. They include bananas, coconuts, and spices. St. Vincent and the Grenadines is also the world's major supplier of arrowroot, a plant. A starchy extract (also called arrowroot) from the root of this plant is used as a thickening in various sauces, puddings, and desserts.

Service industries, including government services and the distributive trades, make the largest contribution to the country's economy but provide fewer jobs than does agriculture. Hotels, restaurants, and tourism are of small but growing importance. Manufacturing, mainly involving the processing of agricultural products, and fishing are of minor importance.

History. A nomadic people called the Ciboney were the first settlers of what is now St. Vincent and the Grenadines. The Arawak, a peaceable people from South America, arrived in the islands about 200 B.C. After about 1,500 years of peaceful existence, they were overpowered by another South American people known as the Carib. On Jan. 22, 1498, Christopher Columbus sighted St. Vincent and named it in honour of the saint whose feast day it was.

The Carib, French, and British struggled for control of the islands until 1783 when, under the Treaty of Versailles, St. Vincent and the Grenadines became a British colony. During the struggle for possession, runaway African slaves from other islands sought refuge in St. Vincent and the Grenadines. They interbred with Carib women to produce an ethnic group called black Caribs. These black Caribs soon outnumbered the original Carib inhabitants.

In 1795, there was an unsuccessful Carib revolt, and most of the Caribs were exiled to Roatan and the Bay Islands of Honduras. The new colonists started sugar plantations and imported African slaves to work them. The British government abolished slavery in 1834 and, without slaves to provide cheap labour, the sugar industry collapsed.

During the 1900's, St. Vincent and the Grenadines progressed toward increased freedom. In 1969, the country became an associated state. It achieved full independence within the Commonwealth of Nations on Oct. 27, 1979. In December 1979, police put down a minor revolt in Union Island by a group seeking more power in the country's new government. In 1983, St. Vincent and the Grenadines, with other Caribbean states, aided the United States in an invasion of Grenada to overthrow a Marxist government there. In 1984, James Mitchell, leader of the New Democratic Party, became prime minister of St. Vincent and the Grenadines. He retained power in subsequent general elections.

Saint Vitus's dance. See Chorea.

Sainte-Beuve, Charles Augustin (1804-1869), a French critic, was the greatest exponent of the biographical method of literary criticism. His works reveal that his main interest was in human psychology and the origin of a literary work in the creator's mind, family, friends, and time.

Sainte-Beuve possessed excellent taste and tireless curiosity. Writing in a delicate, subtle style, he covered the entire field of arts and letters, and probably did more than any other person to determine attitudes on French literature in his time. His brilliant essays were published in *Literary Portraits* (1829-1846), *Contemporary Portraits* (1846), 15 volumes of *Monday Chats* (1853-1862), and 10 volumes of *More Monday Chats* (1863-1872).

Sainte-Beuve was also an outstanding historian of French aesthetic and intellectual movements. *Tableau of French Poetry* (1828) is a sympathetic study of the French origins of romanticism. *History of Port-Royal* (1840-1860) examines Port-Royal, a French convent that became the centre of a religious and literary movement in the 1600's. *Chateaubriand and His Literary Circle* (1860) is a critical assessment of the French statesman and author and his literary circle during the First Empire in the early 1800's. Sainte-Beuve also wrote poetry and a partly autobiographical novel, *Volupté (Pleasures of the Senses)*, 1834).

Sainte-Beuve was born in Boulogne-sur-Mer. He spent much of his career writing for newspapers and for literary magazines.

Saintpaulia. See African violet.

Sakakawea. See Sacagawea.

Sake. See Rice (Other uses).

Sakhalin is a long island off the eastern coast of Siberia. It is about 970 kilometres long, and from 26 to 160 kilometres wide. It has 709,000 people and an area of 76,300 square kilometres. For location, see **Russia** (political map).

Pine and spruce forests cover almost all of Sakhalin. It has a changeable climate and the land is not suited to farming. Most people make a living by fishing, and fish is their most important food. Many animals live on the island, and some people are fur traders. Other industries include logging and the manufacture of wood pulp. The island is also a source of coal, oil, and natural gas.

Dutch navigators were the first to discover Sakhalin. For many years Russia and Japan quarrelled over the island. In 1905, Russia and Japan divided Sakhalin between them. Russia took the northern half of the island, and Japan took over the southern half. The Ainu, a group of people who may have been the first inhabitants of Japan, lived on Sakhalin until the mid-1900's. The discovery of oil on Sakhalin led the Soviet Union to colonize it in 1931. The defeat of Japan in World War II gave the Soviet Union complete control of the island. In 1991, the Soviet Union was dissolved and Russia took control of the island.

Sakharov, Andrei Dmitriyevich (1921-1989), was a Soviet physicist who gained prominence for his research on controlled thermonuclear reactions. His work helped Soviet scientists develop a hydrogen bomb in the early 1950's. However, Sakharov became best known for his efforts to promote human rights and world peace. He received the 1975 Nobel Peace Prize for those efforts. Beginning in the late 1960's, Sakharov and his

wife, Yelena Bonner, repeatedly criticized the Soviet government, charging that it denied Soviet citizens basic human rights. In 1980, the Soviet authorities arrested Sakharov and exiled him to Gorki (now Nizhny Novgorod), an industrial centre that was closed to foreigners. In 1986, he was released from exile and allowed to return to Moscow. In 1989, Sakharov was elected to the newly formed Soviet legislature called the Congress of People's Deputies.

Saki. See Munro, Hector Hugh.

Saladin (1138-1193) was the greatest Muslim warrior of the 1100's. He brought about the Third Crusade by capturing Jerusalem in 1187 (see **Crusades** [The Third Crusade]).

Saladin served as a soldier in the army of Nur al-Din, a Syrian leader. In 1164, Nur al-Din sent Saladin with an army to settle a struggle between members of the government of Egypt. The army returned to Egypt in 1168 to help defend the country against the Christian crusaders. The Syrian army took control of Egypt, and Saladin became *vizier*. The vizier ran the Egyptian government, though the head of state was the caliph.

The caliph of Egypt was leader of the Shiite branch of Islam and thus a rival of the caliph of Baghdad, who was leader of the Sunni sect (see **Islam** [Sects]). Shortly before the Egyptian caliph died, in 1171, Saladin ordered Egypt to join the Sunnis. The caliph of Baghdad later recognized Saladin as sultan of both Egypt and Syria.

After gaining control of Egypt, Saladin extended his rule northward to the Muslim cities of Damascus, Aleppo, Mosul, and Edessa. He then led Muslim armies that captured Jerusalem from the Christians in 1187. Some of his troops were besieged at Acre (now Akko) in 1189. They surrendered after two years to Richard the Lion-Hearted (see **Richard** [I]). Saladin and Richard made a truce in 1192 that gave the coast to the Christians, the interior to the Muslims, and permitted Christian pilgrims to enter Jerusalem.

Saladin is remembered also for his support of theologians and other scholars. After his death his lands were divided among his less able heirs. Saladin was born in Mesopotamia.

Salamander is a timid, harmless animal that looks like a lizard but is related to frogs and toads. It is a type of amphibian (see **Amphibian**). Salamanders live on all the continents except Antarctica and Australia. They are most common in Asia, Europe, and North America.

There are about 370 species of salamanders, making up nine families. They live mainly in temperate regions, but the largest group, the lungless salamanders, are also found in the tropical territories of Central and South America. Most salamanders measure only a few centimetres in length, but the *giant salamander* of China and Japan can grow as long as 1.5 metres.

Most salamanders mate and lay their eggs in water but otherwise live on land. They tend to dwell in rotten logs, under rocks, in caves, and in other cool, dark, moist places. However, some species, such as the giant salamanders, spend their entire lives in water, and a few species never enter water at all.

The body of a salamander. Most salamanders have moist, dark skin and are difficult to see in their natural environment. A number of species, however, are brightly coloured. Some of these species secrete a milky



The red salamander is one of about 370 species.



Spotted salamanders are common in moist woodlands.

fluid through the skin when handled roughly or when in danger. This fluid is poisonous to some animals.

Salamanders have a long tail that is used for swimming. Most salamanders have four legs, but a few species that live in water lack hind legs. Salamanders have a strong sense of smell, and most have a long, sticky tongue that they use for catching food. They eat mainly worms and insects.

The life of a salamander. Like all amphibians, salamanders are *cold-blooded*—that is, their body temperature remains close to that of their environment. During cold periods, they burrow into soil or lie on the bottom of a pond, where they are sluggish and generally inactive. Species that live in mountain streams and springs may remain active throughout the year.

Female salamanders lay many eggs at a time, either in water or in moist ground. Eggs laid in water usually hatch within a few weeks, but those laid on land may require several months to complete their development.

After they have hatched, young salamanders are

called *larvae*. Salamander larvae look somewhat like frog tadpoles but have feathery gills at the sides of their heads. Salamander larvae change into adults through a gradual process called *metamorphosis*. The period of metamorphosis ranges from 42 days to five years, depending on the species. During this period, certain features of the larvae may disappear. For example, most salamanders lose the gills they have as larvae just before they change into adults. As adults, these salamanders breathe with lungs and through their skin.

Scientific classification. Salamanders belong to the class Amphibia and make up the order Urodela (Caudata).

See also *Mudpuppy*; *Newt*.

Salamis is a horseshoe-shaped Greek island in the Saronic Gulf, about 16 kilometres west of Athens (see Greece [map]). It covers 95 square kilometres and has a population of about 28,500. Much of the land is rocky and mountainous. Most of the inhabitants are Albanians. Salamis is also known by a modern name, *Kuluri*, which means *baker's crescent*.

The Greeks and Persians fought a great sea battle near Salamis in 480 B.C. When the Persians advanced after the Battle of Thermopylae, the Athenians sought safety on Salamis. In the Battle of Salamis, Persian ships tried to block the retreat of Greek vessels. The Greeks destroyed half the Persian fleet.

See also *Aristides*; *Themistocles*; *Xerxes I*.

Salazar, António de Oliveira (1889-1970), served as dictator of Portugal from 1933 to 1968. He became prime minister in 1932. The next year he proclaimed a new constitution that made him a virtual dictator. He suffered a stroke in 1968 and was unable to carry out his duties. He was replaced as prime minister by Marcello Caetano.

Salazar was a financial expert and a professor of economics at Coimbra University before he entered government service. He refused the position of minister of finance in 1926, because he felt he would not have enough power to solve Portugal's financial problems. By 1928, Portugal's finances were in such poor condition that the government gave Salazar the power he wanted.

Salazar set up a police state. He put trade unions under government control, and abolished freedom of the press and political expression. He put finances on a firm basis, but he did so at the expense of wages, education, and the well-being of many of the people.

During World War II (1939-1945), Salazar kept Portugal neutral. The capital, Lisbon, became the main link between Allied and Axis nations, and their agents operated freely throughout the country. Yet Salazar maintained Portugal's traditional ties to the United Kingdom, and granted the Allies naval and air bases in the Azores, a Portuguese island group.

Political opposition to Salazar began growing in Portugal in the late 1950's. His policies toward Angola, Mozambique, and the other Portuguese colonies in Africa attracted international attention in the late 1960's. Salazar maintained Portuguese domination over the colonies despite disapproval by the United Nations and rebellion by some Africans.

Salazar was born in Vimieiro, Portugal.

Saldanha is a town on the western coast of South Africa. It is situated 90 kilometres northwest of Table Bay. It shares a municipality with nearby Vredenburg. For the location of Vredenburg, see *South Africa* (political map).

Saldanha is the best natural harbour on the South African coast. Iron ore mined in the northern Cape Province passes through Saldanha Bay. A specially constructed 860-kilometre rail link carries trains that are more than 2 kilometres long to and from Sishen district mines.

Saldanha is a major fishing centre with many canneries and factories. A nuclear power station is located 80 kilometres to the south. The town has a military academy. The town is named after Antonia de Saldanha, a Portuguese admiral who anchored in Table Bay in 1503.

Sale (pop. 13,853) is a city in the Gippsland district of Victoria, Australia. For location, see **Victoria** (political map). Sale lies on the Thomson River, a tributary of the La Trobe. It is surrounded by a prosperous agricultural, grazing, dairying, and irrigation district. Industries in the city include a plastics factory and service companies related to the offshore oil and gas industry.

The Royal Australian Air Force base at East Sale has been an important training school since 1943. In 1965, natural gas and oil were discovered in Bass Strait. Sale became the commercial centre for an operation that provides 70 per cent of Australia's oil and 99 per cent of Victoria's gas requirements.

The district was first settled in 1844. Governor Fitz Roy approved the plan for the village of Sale in 1850. Sale was proclaimed a town in 1924 and a city in 1950.

Sale, Bill of. See **Bill of sale**.

Salem (pop. 38,264) is a city in Massachusetts, U.S.A. It is one of New England's most historic cities. It was the site of witchcraft trials in the 1690's. Around 1850, Salem became a cotton industry centre. Today, the city's products include cables, flashbulbs, games, lamps, plastics, and leather products.

Salem State College is in Salem. The city's many historic houses include the birthplace of Nathaniel Hawthorne and the House of Seven Gables.

Salem witchcraft trials were trials that resulted from the largest witch hunt in American history. The trials were held in 1692 in Salem, a town in the Massachusetts Bay Colony. Nineteen people, both men and women, were convicted and hanged as witches. Another man was pressed to death with large stones for refusing to enter a plea of innocent or guilty to the witchcraft charge. About 150 other people were imprisoned on the witchcraft charges.

The Massachusetts Bay Colony was an English colony. Under English law, witchcraft was punishable by death. Sixteen people had been hanged as witches in New England before 1692.

The Salem trials occurred as a result of a witch hunt that began nearby in the small farming community of Salem Village (now Danvers, Massachusetts). Early in 1692, several village girls began to behave strangely. They crawled under tables, uttered weird sounds, and screamed that they were being tortured. Suspicions of witchcraft soon led to the arrest of three women. More arrests followed.

Some historians believe a dispute over a local minister, Samuel Parris, led to the witch hunt. Parris received much of his support from the poorer farmers of Salem Village. To them, Parris and the village church represented stability and traditional values. They saw Salem, with its increasingly important merchants, as a threat to

their way of life. Parris and his supporters helped lead the witch hunt. Many villagers who opposed Parris or had links with Salem were arrested as witches.

The witchcraft scare lasted about a year. The colony's leading ministers helped stop it. In 1693, the people still in jail on witchcraft charges were freed.

Saleratus. See **Soda**.

Sales, Saint Francis de. See **Francis de Sales, Saint**.

Sales tax is levied on the sale of goods and services. The tax is a certain percentage of the selling price. The main kinds are *general sales taxes* and *excise taxes*. General sales taxes levy a single rate on the sales of many types of consumer goods. The sales tax can be collected by the producer, wholesaler, or retailer—or by all of them. Alcohol, tobacco, and gambling often carry customs and excise taxes which are a valuable source of income for governments. Value added tax is a type of sales tax used in the European Union (EU).

Salesmanship is the ability to sell goods and services. It involves informing people about a company's products and services and persuading them to buy.

Salesmanship, also called *selling*, is one of the most important business activities. A company cannot earn money unless people buy its products. An effective sales force benefits other people in the company. The more the company sells, the more it needs to produce. This creates jobs and benefits the economy as a whole.

Selling is just one part of a process called *marketing*, which includes market research, product development, pricing, advertising, and other activities. Advertising and selling are similar because both operations are aimed at trying to persuade people to buy products. Selling, however, involves two-way communication between a salesperson and a customer. It enables the buyer to ask questions about a product and to receive additional information about it immediately.

There are many types of selling. Most manufacturers sell their products to businesses called *wholesalers*. The wholesalers sell the products to retailers, who in turn sell to the consumer. Consumers buy certain products from salespeople who do not work in shops. Insurance, for example, is sold by people called *insurance agents*. Most salespeople follow the same basic steps in making a sale. These steps are (1) prospecting, (2) preparation, (3) presentation, (4) persuasion, and (5) aftersales responsibilities. In many cases, these steps tend to overlap.

Prospecting is the process of identifying possible customers, who are called *prospects*. In prospecting, salespeople look for individuals who have the means to buy a product, the authority to buy it, and the desire to buy it. People with the authority to buy a product are those who are legally permitted to do so. For example, people under a certain age are not legally allowed to buy tobacco. Only adults have the authority to make such a purchase.

Preparation. Salespeople use several techniques to learn about prospective buyers and their needs. Previous sales records may indicate whether a prospect bought certain products in the past. By studying such records, salespeople may be able to learn whether the customer was satisfied with the purchases.

Salespeople can also learn about prospects by simply observing them. A car dealer, for instance, may see that

a person's current car is a small, fuel-efficient model. The salesperson could assume the customer would want to replace his or her old car with a similar new one. As a result, the salesperson would concentrate on showing the prospective buyer fuel-efficient cars.

Salespeople must also learn about the product they are selling. In this way, they can emphasize the features that would be most appealing to prospective buyers. Salespeople also study competing products so they can stress the ways in which their product differs from those sold by their competitors.

Presentation. A sales presentation generally follows a three-step outline: (1) recognition of the prospect's needs, (2) demonstration that the product offered will satisfy those needs, and (3) asking for the order. But a presentation must be more than an outline. It must be interesting and lively. It must also emphasize the most appealing features of the product and show how owning it will benefit the prospect.

Salespeople may show video cassette recordings, slides, or photographs of people using the product. Or they may produce *testimonials*—written statements received from purchasers who were satisfied with the product and recommend that others try it. Many salespeople also have catalogues that provide pictures of the products and information about them.

In some cases, the salesperson can demonstrate the product itself. To show the picture quality of a television set, for example, a salesperson will turn it on. Or a cooking utensil that is said to be unbreakable can be dropped on the floor to show that it does not break. If the product is too big or too heavy to be carried, the salesperson may use a model of it in the presentation. Samples are useful in selling such goods as foods.

Asking for the order is referred to as "closing." An important skill for salespeople is to recognize when the prospect is ready to buy and then ask for the order.

Persuasion. Most prospects do not immediately agree to buy a product. Instead, they offer some objection to doing so. The prospect may be afraid that the product will not be satisfactory and so hesitate to purchase it. In such cases, the salesperson tries to convince the prospect that such doubts are groundless and that the buyer will, in fact, benefit from owning the product. The salesperson must counter the customer's objections by stressing the benefits of owning the product. A sale can be closed only when the customer's desire to own the product outweighs any objections.

One method of overcoming reluctance is to grant prospects a *trial period* for using the product. Under such an arrangement, the customer can buy the product immediately. But if the buyer is not satisfied with it, he or she can return the product within a certain length of time and receive a full refund.

In some cases, the objection to buy the product will be final—that is, the prospect cannot buy the product or has definitely decided not to do so. At this point, the salesperson can only end the sales pitch gracefully.

Aftersales responsibilities are the tasks a salesperson performs after a sale has been made. The salesperson documents the sale and gives the buyer a receipt. The receipt indicates that the buyer has become the legal owner of the product. If the purchase was made on credit, the salesperson forwards a copy of the re-

ceipt to the company's accounting department so that the customer can be billed. The copy also serves as a record of the purchase so that stocks can be replenished, and it can be filed for future reference.

As nations expanded and economies grew, the salesperson's duties and responsibilities changed. Selling became recognized as a profession that required special training and skills. During the 1900's, the types of merchandise sold became more complex and sophisticated. Salespeople became increasingly responsible for explaining products. They also became an important link between a customer and a company.

Related articles in *World Book* include:

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Direct Selling Association	Marketing
Insurance (The insurance industry)	Retailing

Salford (pop. 217,900) is a metropolitan district and manufacturing city in Greater Manchester, England. Salford lies to the west of central Manchester and on the north side of the Manchester Ship Canal. The former dockland area, Salford Quays, is now an enterprise zone developing new industries. The district includes the towns of Eccles, Irlam, Swinton, and Worsley. Salford has a university, originally founded as a technical institute in 1896.

Salic law was a set of laws written in Latin and founded on Germanic customs and procedure. Historians believe Clovis (466?-511), king of the Salian Franks, had the Salic laws drawn up during his reign.

In the 1300's, the Salic law played an important part in the history of France. The last son of Philip IV died without leaving any direct male heirs. French lawyers used the Salic law to prevent Edward III of England from gaining the throne of France. Edward was the son of a daughter of Philip IV, and the French argued that a kingdom could not be inherited through a woman. Actually, the Salic law simply stated that Salic land could not be inherited by women.

The French recognized Philip VI, the son of a brother of Philip IV, as king of France. As a result, Salic law came to mean that a woman or descendants of a woman could not inherit royal authority.

Salicylic acid belongs to a group of chemical compounds that are used as drugs for reducing fever and pain. Acetylsalicylic acid, one of the most widely used drugs, is prepared from salicylic acid. Acetylsalicylic acid is commonly known as aspirin.

Salicylic acid is also used in treating ringworm and eczema, and in making dyes. It is an effective food preservative, but some countries forbid its use for this purpose, as it can be poisonous in large amounts.

A naturally occurring derivative of salicylic acid called *methyl salicylate* is used as a food flavouring and in ointments designed to relieve muscular pain.

Salicylic acid is a white powder and has the chemical formula $C_6H_4(OH)(COOH)$. It was first prepared in 1838 from *salicin*, a compound found in the bark of willow trees. See also *Aspirin*.

Salinas de Gortari, Carlos (1948-), was elected president of Mexico in 1988. Salinas belongs to the Institutional Revolutionary Party. He succeeded Miguel de la Madrid Hurtado as president. An economist, Salinas served as secretary of planning and budget in de la Madrid's Cabinet from 1982 to 1987.

As president, Salinas took steps to modernize the country's economy, including the sale of hundreds of government-owned companies. He also promoted the establishment of the North American Free Trade Agreement (NAFTA), an economic union among Mexico, the United States, and Canada.

Salinas was born in Mexico City. He earned a bachelor's degree at the National Autonomous University of Mexico in 1969. He later earned two master's degrees and a doctor's degree from Harvard University. Before becoming a Cabinet member, he worked for federal financial agencies.

Salinger, J. D. (1919-), an American author, became famous for his novel *The Catcher in the Rye* (1951). The novel's hero and narrator is a prep-school dropout named Holden Caulfield. Adrift in New York City, Holden learns to face both the phoniness he finds in the adult world and his own weaknesses. In *Catcher*, and in much of the fiction that followed, Salinger humorously and convincingly captured the speech, gestures, and feelings of the young.

Salinger's *Nine Stories* (1953) introduces the Glass family, central figures of later works. One story focuses on Seymour Glass, an eccentric genius whose suicide haunts the family. In *Franny and Zooey* (1961), Franny Glass suffers a spiritual breakdown. Her brother Zooey blames his older brothers for Franny's condition, but he draws on their wisdom to help her. Salinger also focuses on Seymour in three stories first published in *The New Yorker* magazine. These stories are "Raise High the Roof Beam, Carpenters" (1955), "Seymour: An Introduction" (1959), and "Hapworth 16, 1924" (1965).

Jerome David Salinger was born in New York City.



Carlos Salinas de Gortari

Since the 1950's, he has isolated himself. He still writes, but feels that publishing would invade his privacy.

Salisbury (pop. 103,200) is a local government district in Wiltshire, England. At the centre of the district is the city of Salisbury, at the junction of the Avon, Bourne, and Nadder rivers. The magnificent Salisbury Cathedral, near the bank of the Avon, was begun in 1220. Its 123-metre spire is the tallest in England. The spectacular earthworks of Old Sarum lie about 3 kilometres north of the city. Old Sarum was England's chief economic and religious centre before the Roman conquest. All that remains of Old Sarum is a large mound with earthen *ramparts* (defensive banks). The famous site of Stonehenge is also in the district. Stonehenge is the largest prehistoric structure in western Europe. See also **Wiltshire**.

Salisbury, Zimbabwe. See **Harare**.

Salisbury, Marquess of (1830-1903), was a British statesman who was prime minister three times. He entered the Cabinet in 1867 and again in 1874 as secretary of state for India under Prime Minister Benjamin Disraeli. When Disraeli died in 1881, Salisbury became leader of the Conservative Party. He was prime minister from June 24, 1885, to Feb. 6, 1886; from Aug. 3, 1886, to Aug. 8, 1892; and from July 2, 1895, to July 12, 1902. During most of this period of Conservative domination, Salisbury also served as secretary of state for foreign affairs.

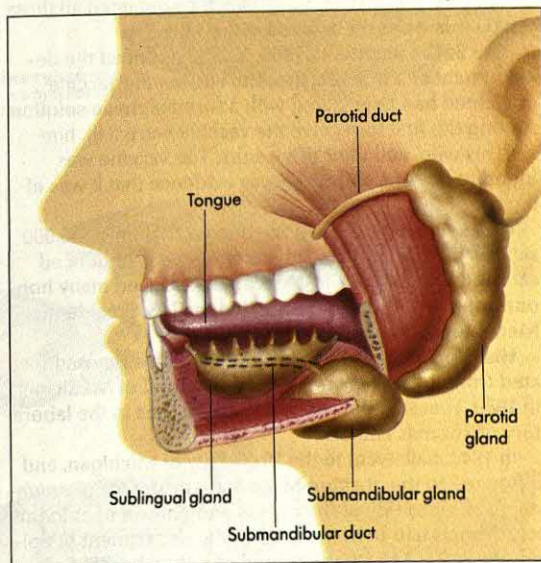
Salisbury was born in Hatfield, Hertfordshire, England. His name was Robert Arthur Talbot Gascoyne-Cecil. Salisbury was educated at Oxford University. He was elected to the House of Commons in 1853, and remained a member until the death of his father in 1868 gave him a seat in the House of Lords.

Salisbury Plain. See **Wiltshire**.

Saliva, a sticky fluid produced in the mouth, is important to the digestion of food. It has a colourless and wa-



Salisbury, England, is famous for its cathedral.



Saliva is produced chiefly by three pairs of glands: the parotid, the sublingual, and the submandibular. Saliva moistens and softens the food, thus helping in chewing and swallowing. It also contains an enzyme that begins the digestion of starches.

tery appearance. It contains some mucus and produces an *alkaline* (acid-neutralizing) chemical action.

Saliva moistens and softens all food that is taken into the mouth. It helps in the chewing and swallowing of food. It also keeps the mouth moist, which is important to comfort. Its most important action is on starchy foods. Saliva contains an enzyme called *ptyalin*. Ptyalin changes starches into such simpler substances as *maltose*. The breaking down of starches into maltose is the first step in digestion.

Three pairs of glands in the mouth and cheeks, known as *salivary glands*, produce saliva. One pair of glands, the *parotid*, is located in front of the ears. Another pair, the *submandibular*, is located under the lower jaw. The third pair of glands is located under the tongue and is known as the *sublingual*. There are several other small glands in the mucous membrane of the mouth that aid in producing saliva.

See also **Mastication**.

Salivary glands. See **Saliva**.

Salk, Jonas Edward (1914-1995), an American research scientist, worked in the field of preventive medicine. He gained his greatest recognition for developing a vaccine that became the first effective weapon in preventing poliomyelitis, also called infantile paralysis (see **Poliomyelitis**).

In addition to his work on poliomyelitis, Salk also made significant contributions to the understanding of influenza. Both poliomyelitis and influenza are caused by viruses (see **Virus**).

Vast amounts of material about immunity had accumulated since "the golden age of bacteriology" in the last half of the 1800's. Salk had to distil this information and apply the findings to his polio vaccine. He found it necessary to weaken the virus with formalin without knocking out its ability to stimulate the body to produce protective antibodies. Since each type of microorganism has its own antibodies, Salk's vaccine contained all three polio virus types recognized at the time.

The Salk vaccine. In 1953, Salk announced the development of a trial vaccine. The viruses the vaccine contained had been killed with a formaldehyde solution. Among the first to receive the vaccine were Salk himself, his wife, and their three sons. The vaccine was found to be safe, and there was evidence that it was effective.

It was further tested during a mass trial on 1,830,000 schoolchildren in 1954. The vaccine was pronounced safe and effective in April 1955. Salk received many honours, and in 1977 he was awarded the U.S. Presidential Medal of Freedom.

His life. Salk was born in New York City. He graduated from the New York University School of Medicine in 1939. There he did research with viruses in the laboratory of Thomas Francis.

In 1942, Salk went to the University of Michigan, and advanced to the position of assistant professor of *epidemiology* (the study of the causes and control of epidemics). Francis had become head of the department of epidemiology at Michigan's school of public health. Salk worked with Francis to develop influenza vaccines. Later, Francis directed the evaluation of the mass tests of the Salk antipolio vaccine. Albert Sabin later developed an effective oral polio vaccine (see **Sabin, Albert B.**).

Salmon is one of the most important food and game fishes. Every year, people throughout the world eat millions of cans of pink or red salmon. Game fishermen also catch millions of salmon annually.

Most of the salmon sold comes from five species that live in the coastal waters of the North Pacific Ocean. A sixth Pacific species lives only in northern Asian waters. One species, called the Atlantic salmon, lives in the North Atlantic Ocean. This fish is actually more closely related to the trout than to the Pacific salmon.

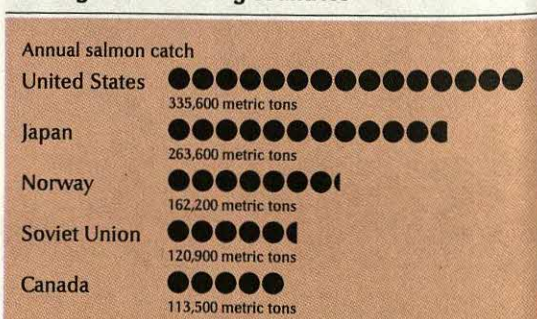
Salmon are born in a freshwater stream, and most of them spend part of their life in the salt water of the ocean. They then return to the freshwater stream of their birth to *spawn* (reproduce). Pacific salmon spawn only once and die soon afterward. Atlantic salmon may swim back to the ocean after spawning and return to fresh water to spawn as many as three more times. Some salmon are *landlocked* (cut off from the ocean) in lakes and streams. Adult salmon swim upstream at spawning time. They battle rushing currents and leap across swirling rapids and over waterfalls as high as 3 metres. When hooked, they struggle furiously to escape.

The life of a salmon. Most salmon spawn during the summer or autumn after swimming upstream as far as 3,200 kilometres from the ocean. The journey may take several months. Female salmon lay their eggs in the gravelly bed of a shallow, rippling stream. A male salmon stands guard as the female turns on her side and digs a saucer-shaped nest in the gravel by swishing her tail back and forth. The female lays her eggs in the nest, and the male fertilizes them with sperm. The female then swims forward a short distance, digs another nest, and lays more eggs. The male and female may repeat the spawning process several times. The gravel dug from each nest normally washes back and covers the previously laid eggs. During spawning, the female lays a total of 2,000 to 10,000 eggs.

The eggs hatch after three or four months, and the baby salmon lie hidden in the gravel for several weeks. They feed on a *yolk sac* (a baglike structure containing food materials) attached to their stomach. Some kinds of salmon leave fresh water for the ocean immediately after they come out of the gravel. Other species may spend up to three years in fresh water. They eat insects and small animal life called *plankton*.

Only a small percentage of the salmon reach the ocean from fresh water. Fish and birds eat some salmon,

Leading salmon-fishing countries



Figures are for 1990, prior to the breakup of the Soviet Union. Source: *Yearbook of Fishery Statistics, 1994*, Food and Agriculture Organization of the United Nations.

and polluted water kills others. Many die trying to make their way through huge artificially created reservoirs.

Salmon that reach the ocean live there from six months to five years. During this period, they feed mainly on shrimp, squid, and small fish. Some salmon travel thousands of kilometres from the river where they were born. Yet zoologists know that most salmon return for spawning to the same stream in which they hatched. Many scientists think salmon navigate in the sea by somehow sensing the magnetic field of the earth and the currents of the ocean. After reaching the coast, the salmon apparently remember the odour of their "home" stream and follow this scent.

Salmon stop eating after reaching fresh water to spawn. They live off fat stored in their body. As the fish travel upstream, their shape and colour change. For example, all male salmon develop a hooked snout. Male pink salmon grow a large hump on their back. Chum salmon of both sexes develop purple streaks on their sides, and sockeye salmon turn bright red.

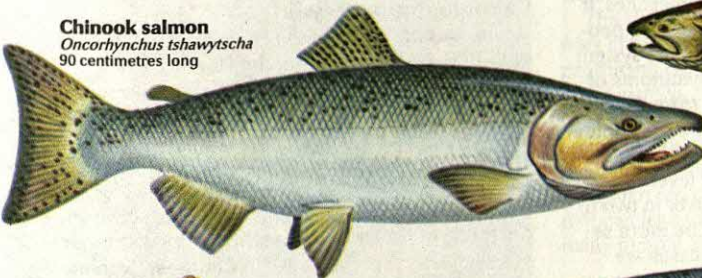
Many salmon do not complete the spawning journey. Commercial fishing crews and game fishermen catch large numbers of the fish. Some salmon are killed by pollutants dumped into the rivers by industries. Artificial sloping waterfalls called *fish ladders* have been built to help salmon travel over dams. But some salmon become so weakened by their efforts to climb the ladders that they die.

Kinds of salmon. There are seven species of salmon: (1) Atlantic salmon, (2) cherry salmon, (3) chinook salmon, (4) chum salmon, (5) coho salmon, (6) pink salmon, and (7) sockeye salmon. All except Atlantic salmon live in the Pacific Ocean.

Some kinds of salmon



Chum salmon
Oncorhynchus keta
60 centimetres long



Chinook salmon
Oncorhynchus tshawytscha
90 centimetres long



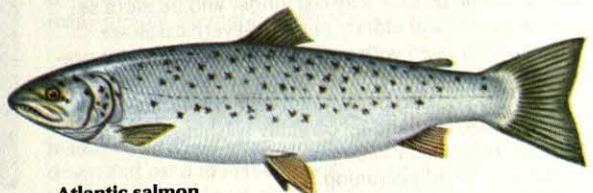
Pink salmon
Oncorhynchus gorbuscha
50 centimetres long



Cherry salmon
Oncorhynchus masou
40 to 70 centimetres long



Sockeye salmon
Oncorhynchus nerka
60 centimetres long



Atlantic salmon
Salmo salar
75 centimetres long

Atlantic salmon are not nearly so plentiful as Pacific salmon. They have diminished in number due to overfishing and pollution. Most Atlantic salmon measure about 75 centimetres long and weigh about 4.5 kilograms.

Cherry salmon, or *masou salmon*, live in coastal waters and rivers of eastern Asia. They vary in length from about 40 to 70 centimetres and weigh from 2.5 to 10 kilograms. They are the least commercially important Pacific salmon.

Chinook salmon, the largest species, are also known as *blackmouth*, *king*, *quinnat*, *spring*, *tule*, or *tyee salmon*. Most chinooks are about 90 centimetres long and weigh about 10 kilograms.

Chum salmon are also called *calico*, *dog*, or *keta salmon*. They grow about 60 centimetres long and weigh about 4.5 kilograms.

Coho salmon are also known as *medium red*, *silver*, or *silverside salmon*. They are about 60 centimetres long and weigh about 4.5 kilograms. In North America, scientists have introduced cohos and other kinds of salmon into the Great Lakes. The salmon provide fishing and help control the number of alewives. The alewives, a species of small fish, had become a nuisance because they multiplied so rapidly (see *Alewife*).

Pink salmon, or *humpback salmon*, are the smallest species. These fish grow to about 50 centimetres in length and weigh about 2.5 kilograms.

Sockeye salmon, also known as *blueback* or *red salmon*, are the most valuable food salmon. A sockeye measures about 60 centimetres long and weighs about 2.7 kilograms. *Kokanee salmon* are a landlocked variety of sockeye salmon with little commercial value.

Salmon fishing. After salmon enter fresh water, their flesh loses flavour and colour. Therefore, fishing crews catch salmon as the fish leave the ocean to journey upstream. Most salmon are caught in nets. Some salmon is sold fresh, frozen, or smoked, but most is canned. Salmon fishing and processing rank as major industries in Alaska and on the North American Pacific coast.

Game fishing for salmon is popular on the Atlantic and Pacific coasts of the United States and Canada. Coastal waters, lakes, and rivers in many parts of the world have been stocked with salmon. But transplanted salmon thrive only in a few places, such as the Great Lakes and New Zealand.

Salmon conservation is based on the theory that a certain number of fish, called the *escapement*, should be allowed to spawn in each stream. Fishing is regulated to ensure the proper escapement. In many areas, conservation programmes must overcome such obstacles as dams, irrigation ditches, and pollution.

The most important advance in conservation has been the development of improved hatcheries. These hatcheries, helped by increasing knowledge of fish nutrition and diseases, can produce thousands of healthy salmon to restock rivers and streams. Other conservation efforts have resulted in new designs for dams and fish ladders. Artificial spawning channels, with controlled water flow and temperature, have also been developed.

The two species of Australian salmon belong to the family *Arripidae*. They are not related to the salmon of the Northern Hemisphere.

Scientific classification. Salmon are members of the trout family, Salmonidae. Pacific salmon are genus *Oncorhynchus*. The Atlantic salmon is *Salmo salar*.

See also **Fish** (The bodies of fish; pictures: Fish hatcheries, Fish of temperate fresh waters).

Salmonellosis is a common type of food poisoning. It is often called *salmonella* because it results from infection by certain types of *Salmonella* bacteria. People get salmonellosis from food or water contaminated with these bacteria. Poultry, milk, eggs, and products made from eggs are the foods that most often carry the bacteria. There are also other types of *Salmonella* bacteria that cause a number of other infectious diseases. For example, the *Salmonella typhi* bacterium causes typhoid fever (see **Typhoid fever**).

Salmonellosis is usually confined to the intestines. It may spread throughout the body in chronically ill people and in people who have a deficient immune system or sickle cell disease. The bacteria cause symptoms of the disease by releasing a poison called a *toxin*. The toxin stimulates the secretion of fluids in the small intestine, producing diarrhoea. Other symptoms of salmonellosis include nausea, abdominal pain, and fever.

Most adults who get salmonellosis recover in two to five days. The disease may last longer and be more severe in infants and elderly people. Severe cases are sometimes treated with antibiotics. People can best prevent salmonellosis by refrigerating prepared foods, by thoroughly cooking poultry and other foods that may carry the bacteria, and by carefully washing the hands before preparing or eating food.

See also **Food poisoning**.

Salome was the daughter of Herodias and the stepdaughter of Herod Antipas, governor of Galilee and Pe-

raea. She is said to have caused the beheading of Saint John the Baptist. The story is told in the Bible in Matthew 14: 6-12 and in Mark 6: 22-28. However, her name is not given in the Bible, where she is only called the daughter of Herodias. According to Matthew's story, Salome danced at a birthday party for Herod. He was so pleased that he offered to grant Salome any wish. At her mother's suggestion, Salome requested the head of John the Baptist. Herod ordered John beheaded and sent the head to Salome on a platter.

Another Salome appears in the Bible as one of the holy women present at the Crucifixion of Jesus and later at the empty tomb of Jesus (Mark 15: 41 and 16: 1). This Salome was possibly the wife of Zebedee and the mother of the apostles James and John.

See also **Herod** (Antipas); **Opera** (The 1900's; The opera repertoire; picture: *Salome*); **Strauss, Richard**. **Salon** refers to a type of room and to certain activities that take place in the room. The word *salon* comes from the Old French word *sale*, which means *great hall*.

Originally, a salon was a large reception room in a palace. It provided an impressive setting for entertaining guests or meeting the public. Some salons were two storeys high, with an arched ceiling and several windows. Many salons had elaborate sculptured and painted decorations on the walls.

During the 1600's and 1700's, artists in the French Royal Academy held exhibitions of their work in the Salon Carré in the Louvre Palace in Paris. These exhibitions became known as *salons*. The term still means an annual exhibition of the work of living artists. Because the Louvre salon was the only public art exhibition in Paris, it established an approved style of art. Many artists protested against the salon's control over public taste. In 1863, the Salon des Refusés was established by artists whose work had been refused by the official salon. Many founders of modern art exhibited there.

The term salon can also mean a gathering of fashionable people. During the 1700's, wealthy Parisians built town houses with elegantly decorated salons. The hostess usually invited writers, philosophers, politicians, and aristocrats. These French salons became famous for their brilliant conversation.

See also **Furniture** (French styles; picture: The French neoclassical style).

Salonga, Jovito Reyes (1920-), a lawyer and politician, was president of the Philippine Senate from 1987 until 1992. He was leader of the Liberal Party and an active supporter of Corazon Aquino at the time she became president of the Philippines in 1986.

Salonga was born in the town of Pasig, at the southern end of metropolitan Manila. He came from a poor family. He graduated in law from the University of the Philippines, and then gained a master's degree and a doctorate in the United States. In 1961, he entered politics as district representative in Congress. Salonga was elected to the Senate in 1965 and reelected six years later. He was an active opponent of Ferdinand Marcos, who became president in 1965. During the period of martial law (1972-1981) declared by Marcos, Salonga was arrested and kept in isolation for several months.

See also **Philippines, Government of the**.

Salonika, or, in Greek, *Thessaloniki* (pop. 406,403; met. area pop. 706,180), is a port on the Gulf of Salonika in

Greece. For location, see **Greece** (map). Until 1912, Salonika belonged to Turkey. *Minarets* (towers of Muslim houses of worship) rise above the city.

Salonika is a leading industrial centre and has a modern business area. Its industries include foundries, shipyards, flour mills, and textile mills. The city also produces tobacco, soap, and leather products. The port of Salonika, opened in 1901, is a major Balkan outlet to the Aegean Sea. Chief exports are tobacco, hides, and manganese and chromium ores. Salonika has a university and several research institutes.

Cassander, king of Macedonia, founded Salonika in 316 or 315 B.C. by uniting the town of Therma with a number of nearby villages. He named the city after his wife. Salonika has been fought over and ruled by almost every neighbouring country. The Muslims invaded it in A.D. 904, and sold 22,000 of its people into slavery. From 1430 until 1912, the city belonged to the Ottoman (Turkish) Empire. Salonika fell to Greece in 1912 in the first Balkan War.

During World War I, the Allies used Salonika as a base for campaigns. A fire destroyed the business area in 1917, but the area was rebuilt. The Germans occupied Salonika during World War II, and it suffered considerable damage. Greeks freed the city in October 1944.

Salop. See **Shropshire**.

Salpiglossis is a plant in the potato family. Cultivated as a garden plant, it is related to the petunia. Like the petunia, it has trumpet-shaped blossoms, but they are much more handsomely coloured. The colours cover a wide range, including deep red, pink, purple, brownish orange, salmon, yellow, and white. The petals have a rich velvety sheen and are often streaked with yellow and other colours. The salpiglossis is an annual plant. It grows about 46 centimetres high and has several flowers near the top of each stalk.

Scientific classification. The salpiglossis belongs to the nightshade family, Solanaceae. It is *Salpiglossis sinuata*.



The salpiglossis has trumpet-shaped blossoms. These blossoms have a wide range of colours—from deep red to white.

Salsify is a biennial garden vegetable. It is also called oyster plant because its fleshy root has an oysterlike flavour. The plant is native to the Mediterranean area, but it is now widely cultivated on both sides of the Atlantic. The tapering roots are used in Europe and America as a vegetable. A common method of preparation is boiling until tender, and creaming. They are also good boiled, then dipped in biscuit crumbs and fried. Farmers cultivate salsify in the same manner as the parsnip. The roots can be kept over winter, either in the ground or stored in cool, moist earth.

Scientific classification. Salsify belongs to the composite family, Compositae (Asteraceae). It is classified as *Tragopogon porrifolius*.

See also **Parsnip**.

Salt is a clear, brittle mineral that has been used to flavour and preserve food since ancient times. Today, salt is also used in the manufacture of a large number of chemicals and chemical products.

Salt consists of the elements sodium and chlorine. Its chemical name is *sodium chloride* and its formula is NaCl. Its mineral name is *halite*. Salt usually forms clear crystals that are almost perfect cubes. However, impurities in the salt may make it appear to be white, grey, yellow, or red. Table salt also appears to be white, but it actually consists of clear cubes.

The source of all salt—even deposits that are located underground—is *brine* (salty water) from seas, salt lakes, and similar bodies of water. Salt deposits that now lie underground were formed by the evaporation of seawater millions of years ago.

The United States and China rank as the leading countries in the production of salt. Other important salt-producing countries include Germany, Canada, India, and Australia.

Salt is necessary to good health. Human blood contains salt, and body cells must have salt to function properly. However, some studies have suggested that too much salt or other sodium compounds in a person's diet can lead to high blood pressure. For this reason, many people attempt to reduce their salt intake.

Uses of salt

In the chemical industry. The chemical industry, which consumes the largest amounts of salt, uses it mainly to produce other chemicals. Salt can be broken down and used to make a variety of sodium and chlorine products. A large amount of salt is used to make a sodium compound called soda or soda ash. Soda is used primarily in the manufacture of glass and soap.



The salsify root acquires an oyster flavour after a heavy frost, and so the vegetable is often called *oyster plant*.



A salt block attracts cattle in a pasture. Salt is an essential food for cattle and other livestock.

water is pumped down the central pipe to the salt deposit. The water dissolves some salt to form brine. The brine is then pumped to the surface through the outer pipe. The brine is either shipped as a liquid or evaporated in special devices called *vacuum pans*.

How table salt is made

After salt has been obtained by mining or evaporation, it is sorted for quality and then crushed, ground, and screened into batches according to particle size. High-quality salt that has been ground into fine particles is used as table salt. This fine-grained salt tends to cake at high humidities, so manufacturers add a *free-flowing agent* (substance that prevents caking) to it before packaging. Common free-flowing agents include magnesium carbonate, calcium carbonate, calcium silicate, and calcium phosphate. All of these compounds are colourless, odourless, tasteless, and harmless.

Much of the table salt purchased by consumers is also *iodized*—that is, it has potassium iodide or sodium iodide added to it. A lack of iodine in a person's diet can result in a condition called *goitre*, in which the thyroid gland becomes enlarged. A small amount of iodine is enough to prevent goitre, and the addition of iodine compounds to table salt enables large numbers of people to get the iodine they need.

History of salt

Salt has been a precious commodity since ancient times. It was often traded ounce for ounce for gold. The early Chinese used coins made of salt for currency. In many areas around the Mediterranean Sea, salt cakes were used as currency. Several ancient cultures also levied taxes on salt.

The main sources of salt in ancient times were dry coastal areas, particularly those surrounding the Mediterranean Sea. The earliest trade routes centred on Spain, Italy, Greece, and Egypt, and many of the first

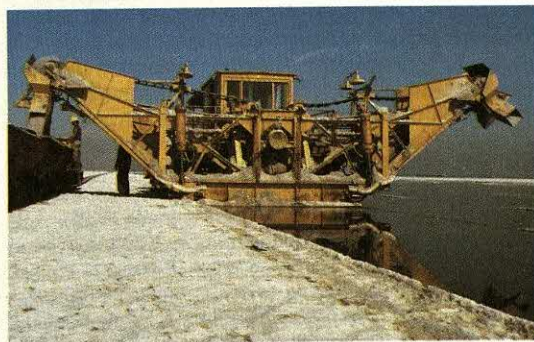
roads and caravan routes were established for transporting salt. A number of cities, including Genoa, Pisa, and Venice, developed as centres for the salt trade.

In the 1300's, people near the coast of the North Sea in northern Europe began trading for salt, which they needed to preserve fish for shipping to inland markets. Later, salt was obtained by boiling the brine from salt springs, and many cities and towns grew up near such springs throughout Europe.

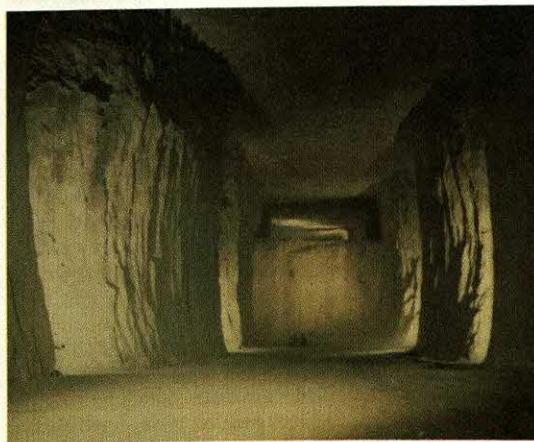
The process of boiling brine to obtain salt required large supplies of wood for fuel, but this problem was partly solved in the 1700's after coal began to be widely used. England became the largest producer of salt at that time, partly because of its abundant supply of coal.

Deep-drilling technology was introduced into salt production in the early 1800's. Most early wells were drilled to improve the quality of salt springs used in salt production and to locate new ones. Production of salt from underground mines began in the mid-1800's.

Drilling helped revolutionize knowledge of the earth's layers. This new knowledge led to increased exploration for salt, potash, and petroleum, and salt exploration indirectly gave rise to such industries as the potash industry and the petroleum industry.



A salt-harvesting machine collects salt that comes from sea-water. The water is channelled into empty ponds, where it evaporates. The salt, which remains, is then taken to a refinery.



A salt mine has cavelike passages. The salt dome above is being mined by the room-and-pillar method. About half the salt is removed, leaving permanent salt pillars for roof support.

Today, several governments are investigating the possibility of storing radioactive wastes in underground salt mines. Salt mines have several characteristics that make them good sites for radioactive wastes. For example, they have remained stable and dry for millions of years, and most salt mines occur in areas where earthquakes are extremely rare. Salt also is capable of absorbing heat from surrounding objects, and it flows to seal up fractures that form in the walls.

Related articles in World Book include:

Fishing industry (How fish are processed and marketed)	Ocean (Composition)
Food preservation (Curing)	Salt, Chemical
	Thirst

SALT. See **Strategic Arms Limitation Talks.**

Salt, Chemical, is a compound that results when a base neutralizes an acid. In this reaction, the metal in the base displaces the hydrogen in the acid. For example, ordinary table salt, sodium chloride, is formed when the base sodium hydroxide neutralizes hydrochloric acid. See **Neutralization.**

Salts are among the most important chemical compounds. They are used in making many industrial and agricultural chemicals. For example, sodium chloride is used in making chemicals needed in the manufacture of rayon, soap, and many other products. The salt ammonium nitrate is used in fertilizers to add nitrogen to soil. Plants and animals need various salts in order to stay healthy. For example, the salts sodium chloride and potassium chloride supply *ions* (electrically charged atoms) needed by nerve cells.

The earth's crust contains many salts. The most abundant salt, sodium chloride, is found in large land deposits and in the ocean. The salt calcium carbonate is found in limestone and in the shells of sea animals. Well-known natural salt deposits include Great Salt Lake in the U.S.A. and the Siberian deposits in Russia.

The salt formed when a base completely neutralizes an acid is called a *normal salt*. Sodium sulphate (Na_2SO_4) is a normal salt. Incomplete neutralization may produce either an acid salt or a basic salt. These salts act like acids or bases as well as like salts. Acid salts contain hydrogen ions, as in sodium bisulphate (NaHSO_4). Basic salts contain hydroxyl radicals, as in basic bismuth chloride ($\text{Bi}(\text{OH})\text{Cl}_2$ or $\text{Bi}(\text{OH})_2\text{Cl}$).

A salt crystal contains positive and negative ions in a regular, repeating arrangement. This arrangement is called an *ionic lattice*. When the salt crystal dissolves in water, these ions are released and move about freely in the solution.

A *simple salt* such as sodium chloride is made up of only two kinds of ions. One ion is positive and the other is negative. When two simple salts form crystals, the resulting substance is called a *double salt*. Alum, a double salt of aluminium sulphate and potassium sulphate, is used to make cement (see **Alum**).

Related articles in World Book include:

Carbonate	Halogen	Nitrite	Sulphide
Chloride	Nitrate	Sulphate	

Salt dome. See **Salt** (Salt from the ground); **Petroleum** (How petroleum was formed; picture: Where petroleum is found).

Salt Lake. See **Great Salt Lake.**

Salt Lake City (pop. 159,936; met. area 1,072,227) is the capital and largest city of Utah, U.S.A. The Church of

Jesus Christ of Latter-day Saints, commonly called the Mormon Church, has its headquarters there. Its leading industries make chemicals, electronics, food products, metal products, petroleum, and steel. Salt Lake City is one of the chief centres of culture, finance, industry, and transportation of the Rocky Mountain States.

Salt Sea. See **Dead Sea.**

Saltbush is the popular name for more than 1,400 *species* (kinds) of Australian plants. They are softwood semi-shrubs or herbs that resist drought. Most of them are grey-green or silvery. They are called saltbushes because of the salty character of the plants and because they grow in salty marshes and salt pans and on sea shores. Most saltbushes, especially the inland kinds, are excellent fodder.

Scientific classification. The most common kinds of saltbush belong to the goosefoot family, *Chenopodiaceae*, genus *Atriplex*.

Saltee Islands are two islands off the coast of Wexford, in the southeastern corner of the Republic of Ireland. The larger of the two, Great Saltee, is about 6 kilometres from the fishing village of Kilmore Quay on the mainland. The island is now a bird sanctuary. Little Saltee lies 3 kilometres from the mainland. Both islands are uninhabited.

Salto (pop. 80,787) is the second largest city in Uruguay. It is located 97 kilometres north of Paysandú (see **Uruguay** [map]). The city provides an important trading centre for the farmers and ranchers of northern Uruguay. Salto is sometimes called the *City of Oranges* because of its large orange and tangerine groves.

Saltpetre, also called *nitre*, is a mineral known to chemists as *potassium nitrate* (KNO_3). It occurs in limestone caves. Industry uses saltpetre to prepare matches, gunpowder, explosives, and fertilizers. Chemists use it as a reagent in analytical chemistry. It is also used as an oxidizer in liquid rocket fuel propellants.

Saltpetre occurs as colourless or white crystals or crystalline powder. It dissolves in water and melts at about 337° C. Saltpetre is manufactured by reacting potassium chloride with sodium nitrate or nitric acid.

The name *saltpetre* also refers to other minerals. The most important is *Chile saltpetre*, which is composed of sodium nitrate (NaNO_3). It is used to make fertilizer, nitric acid, and potassium nitrate. *Lime saltpetre*, or *Norwegian saltpetre*, is calcium nitrate ($\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$). It is made from limestone, and is used to make fertilizer, matches, explosives, and other chemicals. Barium nitrate ($\text{Ba}(\text{NO}_3)_2$) is sometimes known as *barya saltpetre*. It is used to make barium oxide (BaO) and green fireworks.

Salts are saline laxatives. Some common salts are *Epsom salt* (magnesium sulphate), *Glauber's salt* (sodium sulphate), and *Rochelle salt* (sodium and potassium tartrate). Salts act in the intestines by causing water to accumulate and move waste materials. Salts are valuable, but excessive use of them may irritate the intestines.

See also **Glauber's salt.**

Saltwater fish. See **Fish** (Where fish live; pictures).

Saluki, also called *gazelle hound*, is believed to be the oldest purebred dog in the world. It was developed in the Middle East about 5000 B.C. One of the swiftest dogs, the Saluki was once teamed with hawks for hunting gazelles. The hawk struck the prey and the Saluki held it down until the hunters arrived. The Saluki has a

smooth, soft coat, with fringes of long hairs on its ears, legs, and thighs. It is 58 to 70 centimetres high at the shoulder and weighs from 13 to 30 kilograms. See also **Dog** (picture: Hounds).

Salute is a gesture of greeting that generally expresses respect or courtesy. Various types of military salutes show respect to an officer, a flag, or a country. Other salutes include the handshake and the elaborate gestures with weapons made by fencers.

Military hand salutes. Military salutes are similar in many Western countries. Army regulations specify the form of military hand salutes. In the U.S. Army, for example, soldiers must use the hand salute at a distance of not more than 30 paces and not less than six paces. Navy personnel must be wearing head covering when they salute. Aboard ship, sailors salute an officer only at the first meeting during the day, except when reporting in the course of duty. Soldiers in uniform must stand at attention and salute during the national anthem and while the flag is raised or lowered. A soldier who is running should slow to a walk before saluting. Only soldiers in good standing may salute. A prisoner may not salute.

Some dictatorships adopted special salutes that all people had to use. In Fascist Italy and Nazi Germany, civilians and soldiers saluted by holding their right arms out at an angle, palms down. Russian and Spanish soldiers and civilians often used a clenched-fist salute with their right arms. Such salutes were often adopted by political parties.

Salutes with weapons. Soldiers in formation carrying rifles *present arms* to officers. They do this by holding the rifle vertically in front of themselves, with the trigger forward. Marching soldiers, in formation or singly, give the *rifle salute* by raising their left forearms, with wrists and fingers in a straight line, and touching their rifles at a point just behind the rear sight.

Planes and ships also exchange salutes. Fliers often dip, or tilt, the wings of their planes. Ships passing on the high seas salute by dipping their flags once. Mer-

chant ships in port outside their own country raise the national flag of the country that they are visiting.

Other salutes. Cannon, drum flourishes, and music are often used to salute visiting dignitaries. The number of rounds fired depends on the importance of the visitor. When a head of state visits a country, armed forces usually give a 21-gun salute, four ruffles and flourishes on the drums, and the visitor's national anthem. Other salutes may be given with as few as five guns. Warships have similar salutes.

Salvado, Dom Rosendo (1814-1900), a pioneer Roman Catholic priest, was one of the founding fathers of the monastery in New Norcia, Western Australia.

Salvado was born in Spain. In 1845, he offered to move to Western Australia as a missionary priest. Salvado wished to establish a Benedictine mission near Perth. He hoped that the monastery would be completely self-supporting and similar to monasteries found in European cities. According to Salvado's plans, a particular concern of the monastery would be the education and welfare of Aborigines. Other missionaries joined him in 1846. In a short time, they had established themselves beyond the limits of settlement in a fertile area. They named this area New Norcia.

The mission station and monastery were barely underway when Salvado was appointed bishop-elect of Port Victoria in the Northern Territory. He was consecrated in Rome in 1849. He spent the next four years in Europe collecting funds for the mission.

Salvado returned to Perth in 1853. By 1857, he was back in New Norcia, where he worked unstintingly for the Aborigines. He died in Rome.

See also **New Norcia**.

Salvador (pop. 1,496,276; met. area pop. 1,772,018) also called Bahia, is the third largest city in Brazil. Only São Paulo and Rio de Janeiro have more people. Salvador serves as the capital of the state of Bahia and is also a busy Atlantic port. It lies on Todos os Santos Bay. For location, see **Brazil** (political map).

Salvador's port lies along a beach at the foot of a steep cliff. Lifts and winding roads lead up the cliff from older sections of the city to newer ones. Palm trees and white buildings with red tile roofs line the streets. Salvador is known for its many highly decorated churches, some of which date from the 1700's.

Salvador's main industries are food and tobacco processing, textile manufacturing, petrochemical production, and the production of platforms and other equipment for oil exploration. Leading exports are cacao, fruit and fruit juices, petroleum, sugar, tobacco, and vegetable oils. Salvador is the home of the University of Bahia and the Catholic University of Salvador.

Salvador served as the capital of the Portuguese colony of Brazil from 1549, when the city was founded, until 1763. Industrial development programmes have stimulated the city's growth since 1940.

Salvador, El. See **El Salvador**.

Salvage is money or goods paid to those who save ships or cargo abandoned at sea. Help which is given to a vessel in distress or danger is called *salvage service*. Salvage is granted for acts on the high seas but in some countries, courts also allow salvage for saving goods, ships, and life on inland waters.

The *salvor* is a person who helps to save a ship other



Presenting arms is a salute performed with a rifle.



The Canadian salute is like the U.S. military salute.



The British salute is given with the palm facing out.

than the one on which the person sails. Salvors cannot collect salvage for helping to save their own ship. Salvage can be collected only for saving a ship that sails under its own power, or a moving barge. It is not granted for a barge or other floating structure moored to a shore or dock. The ship saved must be brought to a safe place, ready to be returned to its owner for repair.

Some countries have fixed by law the amounts to be paid in salvage cases. In countries that have no such laws, the courts grant salvage claims based on conditions under which the act has been performed.

The term *salvage* is also used to describe goods recovered from emergencies on land. These emergencies include floods or fires.

See also **Diving, Underwater; Flotsam, jetsam, and lagan.**

Salvation. See **Religion** (A doctrine of salvation); **Protestantism** (Faith and grace); **Roman Catholic Church** (Sin and salvation).

Salvation Army is an international Christian religious and charitable organization. It is set up and operated on a military pattern, and its leaders have the ranks of military officers. The Salvation Army works to foster a love of God and to provide for the needy.

Services and activities. The basic unit of the Salvation Army is the corps community centre. Each centre is directed by a commanding officer who administers both religious and social service activities. These centres conduct a varied programme, providing religious services, counselling, moral education, and other social services. In addition, the Salvation Army operates a variety of institutions, including hospitals, drug and alcohol rehabilitation centres, camps, boys' and girls' clubs, senior citizen residences and clubs, and day-care centres. It also provides family assistance and aid to prisoners and their families. The Salvation Army includes many musicians who use music as a way to preach the gospel.

Much of the worldwide service of the Salvation Army

is given to people in less developed countries. These services include education, basic needs, vocational instruction, and disaster relief.

History. William Booth, a Methodist minister, founded the Salvation Army in London in 1865. That year, he began conducting meetings to bring the gospel of Jesus Christ to the people of London's East End. His work was well received, and he organized a group known as the Christian Mission. In 1878, the group changed its name to the Salvation Army. The organization soon spread outside the United Kingdom. It was established in a number of countries by the late 1800's.

Today, the Salvation Army works in over 85 countries. It has about 25,000 men and women serving as officers. Each officer is an ordained minister. The Salvation Army has more than 14,000 corps community centres worldwide. There are about 1½ million members worldwide.

See also **Booth, William.**

Salvation Jane, also known as *Paterson's curse*, is a weed found in all parts of Australia except Western Australia. A farmer named Paterson, who lived in New South Wales, may have introduced it from Europe.

Salvation Jane is a low-growing plant with hairy leaves and purple flowers that bloom in spring. It covers hectares of ground in sheep and wheat country.

Scientific classification. Salvation Jane belongs to the boraginaceae family, Boraginaceae. It is *Echium lycopsis*.

Salvia is a group of plants that grow in the temperate and warm regions of the world. Salvias have two-lipped flowers that range in colour from white and pale yellow to blue, purple, and scarlet. Gardeners use many kinds as ornamentals, including the *scarlet sage*, which has brilliant red flowers. It is native to Brazil, but is grown in other parts of the world. The *garden sage* used to flavour foods is a *salvia*.

See also **Sage.**

Scientific classification. Salvias are in the mint family, Labiales (Lamiaceae), genus *Salvia*. The scarlet sage is species *S. splendens*, and the garden sage is *S. officinalis*.



Salvia

Salween River, also called Salwin, is an important river of Burma. It rises in eastern Tibet, and flows through eastern Burma to the Bay of Bengal. It empties into the ocean near Moulmein. The river, 2,414 kilometres long, drains eastern Burma and western Thailand. It has little value as a commercial waterway, because much of it flows through a gorge. In its lower course, the Salween River is important for crop irrigation.

The Salween Delta is one of the most fertile sections in Burma. During flood season, the upper Salween River rises nearly 30 metres above its low water level and becomes a raging torrent. A suspension bridge carries the Burma Road over the upper river.

Salzburg (pop. 138,213) is a city located in the mountains of northwestern Austria. For location, see **Austria** (map). Salzburg is best known for its annual music festi-



A Salvation Army volunteer visits a nursing home. Other services include work schemes and housing for the poor.

vals, which attract music lovers from all parts of the world. Wolfgang Amadeus Mozart, one of the world's greatest composers, was born in Salzburg. Salzburg is the capital of Salzburg province.

SAM. See Guided missile (Surface-to-air missiles).

Sama-Veda. See Vedas.

Samara (pop. 1,250,000) is a major Russian manufacturing centre and Volga River port (see **Russia** [political map]). A large oil field and rich grain fields lie nearby. Samara's hydroelectric power plant includes a dam across the Volga. Manufactured products include aircraft, food products, and locomotives. Samara was renamed Kuybyshev in 1935, when Russia was a republic of the Soviet Union. It was renamed Samara in 1991, shortly before the Soviet republics became independent countries.

Samaria was the name of a city and its surrounding region in ancient Palestine. King Omri built Samaria in about 800 B.C., and made it the capital of the kingdom of Israel. The king named it after Shemer, who owned the land where it was built.

Assyria conquered Samaria in 721 or 722 B.C., after a siege of three years. In 331 B.C., the city fell to Alexander the Great. Then Hyrcanus attacked and destroyed it in 120 B.C. It was later rebuilt by Herod the Great, who called it *Sebaste*. Excavations begun in 1909 have yielded many ancient treasures. According to tradition, John the Baptist is buried in Samaria. Remains of the Crusaders' church, built in the 1100's, have been found. Sabastiyah, Jordan, now stands on the site of Samaria.

See also **Samaritans**.

Samaritans were citizens of ancient Samaria. The Assyrians destroyed Israel in 721 or 722 B.C. and took the ablest Israelites to Assyria as captives. The Assyrian ruler then forced people from eastern Assyria to settle in the region of Samaria (see **Samaria**). The new settlers brought their own religious ideas, but also sought to please "the god of the land." Many of them intermarried with the remaining Israelites. People who have this mixed ancestry and mixed religion came to be called *Samaritans*.

The Samaritans adopted the *Torah*, the first five books of the Hebrew Bible, as their scripture. But the Hebrews to the south refused to associate with them, and considered their religion inferior. When the Hebrews rebuilt their temple, they refused help that the Samaritans offered. Eventually, the Samaritans built a temple of their own, but it was destroyed in 128 B.C.

In Jesus' time, the Jews looked down on the Samaritans as foreigners. Jesus told a story about the Good Samaritan who aided a Jew who was robbed and injured by thieves after the man had been refused assistance by other Jews (Luke 10:30-34). The story is ironic because the Samaritans were not expected to show sympathy toward Jews. The same theme appears in the story of Jesus' healing of 10 lepers. Only the "foreign" Samaritan leper returned to thank Jesus (Luke 17:11-19).

About 500 Samaritans now live in two communities in the state of Israel. They are the only living descendants of the Biblical Samaritans.

Samaritans is an organization that helps people who are suicidal or despairing. Members of the organization try to help and befriend anyone with a serious problem who telephones or visits one of their centres. There are

Samaritans centres throughout the United Kingdom and Ireland. The centres are open 24 hours a day, every day of the year. The organization has a few full-time paid workers. But almost all of its work is done by volunteers who serve a few hours each week. Volunteers come from all walks of life, and few have relevant professional training. Each new volunteer goes through a preparation course and is evaluated before being allowed to act as a Samaritan. The organization is financed entirely by donations. The Samaritans was founded in 1953 by Chad Varah, a clergyman in London.

Samarium is a chemical element with symbol Sm. It is one of the rare-earth metals. Its atomic number is 62 and its atomic weight is 150.36. Its density is 7.536 grams per cubic centimetre at 25 °C (see **Density**). It is named after the Russian engineer Colonel Samarski. Paul Émile Lecoq de Boisbaudran of France discovered samarium in 1879. Samarium is best separated from other rare earths by ion-exchange or solvent-extraction processes. It has a silver colour and slowly oxidizes in air. The common oxide, Sm₂O₃, has a pale yellow colour, and is rapidly soluble in most acids. The metal melts at 1074 °C and boils at 1794 °C. Alloys of samarium and cobalt are excellent magnetic materials and have many commercial uses.

See also **Element**, **Chemical** (table); **Rare earth**.

Samarqand (pop. 515,000) is the second largest city and former capital of Uzbekistan. For location, see **Uzbekistan** (map). The city is an educational centre. Factories manufacture radio components, silk goods, superphosphate, and tractor parts.

Samarqand occupies the site of ancient Maracanda. Alexander the Great destroyed Maracanda in 329 B.C. In the 1300's, Tamerlane, a Mongol conqueror, chose the city as his capital.

Sambanthan, Tun Veerasamy Thirugnan (1919-1979), was a leading member of the Indian community in Malaysia. He was born in Sungai Siput, Perak. He was educated in Perak and India. After graduation, he became a rubber planter in Perak. Sambanthan worked among Indian labourers promoting the Tamil language and culture. Later, he became active in Malayan politics. From 1955 to 1971, he served as president of the Malayan (later Malaysian) Indian Congress (MIC). He and his party worked with United Malays National Organization (UMNO) and the Malayan Chinese Association (MCA) to form an Alliance party. Under the leadership of Tunku Abdul Rahman, they contested the federal election in Malaya in 1955. The Alliance won more than a two-thirds majority. Sambanthan took part in the negotiations for Malayan independence in 1957. Between 1955 and 1978, he served as a government minister in a number of posts dealing with labour, health, works, communications, and national unity.

Samnites were members of an ancient tribe in what is now southern Italy. The Samnites are known chiefly for their fierce battles against the Romans. The Romans expanded their empire to Samnite territory during the 300's B.C. The Samnites defeated the Romans at the Battle of the Caudine Forks, but the Romans overpowered the Samnites in the 290's B.C. This greatly reduced the Samnite population. In the Social War of the 80's B.C., the Romans crushed the Samnites. Most of the Samnites then adopted the Roman customs and language.

Samoa is a group of islands in the South Pacific Ocean. This group of islands was once called the Navigators Islands because of the fine canoes built by the Samoans. Samoa covers 3,039 square kilometres and has a population of about 193,000. Almost all of the people are Polynesians.

The Samoan island chain is divided into two political units. The western islands of the chain—which consist of Savai'i, Upolu, and several smaller islands—make up Western Samoa. Western Samoa has been an independent nation since 1962. The eastern islands of the chain, which include Tutuila and several smaller islands, are part of American Samoa, a possession of the United States. The United States acquired the islands of American Samoa in stages between 1900 and 1925.

Nearly all the Samoan islands are volcanic formations, and coral reefs surround most of them. Rich forests and flat lands slope gently toward the sea. The climate is hot and rainy.

See also **American Samoa; Western Samoa.**

Samos is a Greek island in the Aegean Sea. It is separated from the coast of Turkey by the Samos Strait (see **Greece** [map]). Samos covers 476 square kilometres and has a population of 31,629. The island's economy relies on tourism, winemaking, and the production of forest products, tobacco, and grapes. The port of Vathi is the capital. Samos was once part of ancient Greece. It was part of the Ottoman Empire from the mid-1400s until 1913, when it was reclaimed by Greece after the Second Balkan War.

Samoset (1590?-1655) was one of the early Indian friends of the Pilgrim settlers of the Plymouth Colony in the United States. He was a *sagamore* (chief) of the Pemaquid Indians, and apparently first came into contact with Englishmen when he met some fishermen along the coast of Maine. He learned a little English from them. In March 1621, he startled the Plymouth colonists by appearing on the street and welcoming them in broken English. He later introduced the leaders of the colony to Massasoit, the Indian chief of the Plymouth area. In 1625, Samoset made what is believed to be the first deed of Indian land to English colonists. He transferred 4,856 hectares of his tribe's land to John Brown, one of the settlers.

Samothrace, also called Samothraki, is a Greek island that is often mentioned in Greek mythology. The island covers 178 square kilometres in the Aegean Sea (see **Greece** [map]). It has a population of 2,871. Tourism and the production of olives and fruit are the leading industries. Ruins found on Samothrace date from 500 B.C. In 1863, the famous statue of the Winged Victory of Samothrace was found on the island (see **Winged Victory**).

Samoyed is a dog bred by the Samoyed peoples of northern Siberia. It is related to the spitz and the chow. The Samoyed is used to guard reindeer herds and to pull sledges. The dog is intelligent, has a pleasant disposition, and is fast. It has a muscular body covered with long, white hair. It stands between 48 and 60 centimetres high at the shoulder and weighs from 23 to 30 kilograms.

See also **Dog** (picture: Working dogs).

Sampan is a small boat used chiefly in rivers and harbours in China, Japan, and nearby islands. It usually has a cabin with a roof made of mats. Many people use

these boats for homes. They are rowed with one or more oars, and some have a sail. See also **Shelter** (picture: Oriental houseboats).

Sampler is a small square or strip of cloth covered with sample patterns of needlework. The term *sampler* comes from the Latin word *exemplar*, meaning a *pattern*. Adults first used samplers to record patterns of embroidery or lace. But as early as the 1500s, young girls made samplers for practice or to show their skill.

Samplers were made of coloured silks stitched on wool or linen canvas, or of lace patterns on closely woven linen. The girls often embroidered letters, numerals, quotations, and verses to gain experience with different techniques. Sometimes a girl would add her name, age, and the date the sampler was made. Many samplers had intricately embroidered birds, flowers, patterns of Bible verses, and even tiny human figures.



A colourful sampler, above, embroidered as a school project by an American girl, is a prized example of folk art.

Samplers are mentioned in the literature and wills of the early 1500s. Many styles and shapes were produced in Europe and the United States until the end of the 1800s. Today, many museums and private collectors own early samplers.

Sampling. See **Statistics** (Sampling).

Samson was a folk hero of ancient Israel, famed for his great strength. His story is told in the Old Testament, Judges 13-16. The story reflects the beginnings of Israel's struggle with the Philistines in the 1000s B.C.

Consecrated before his birth by his mother's vow, Samson was forbidden to drink wine, eat impure food, or cut his hair. He fell in love with a Philistine woman who was unfaithful to him. So he set fire to the fields of her people. When the Hebrews handed him over for punishment, he broke loose and killed 1,000 Philistines with the jawbone of an ass. Later, the Philistines tried to capture him in Gaza by locking the city gates. But he tore out the gates and carried them away.

Samson's downfall came when he fell in love with a second Philistine woman, Delilah. She learned that the secret of his strength lay in his hair, and she had his

head shaved while he slept. Samson was easily taken, blinded, and made to work as a slave. At the festival of the god Dagon, when the temple was filled with people, the Philistines led Samson in so the crowd could make fun of him. But his hair had grown back, and he was strong again. He seized the pillars that supported the roof, and pulled the building down, killing himself and thousands of his enemies.

See also *Delilah*.

Samuel, Books of, are two books of the Bible, called I Samuel and II Samuel. They were originally a single book. I Samuel includes stories about the leader Samuel, and about how Samuel anointed Saul to be the first king of Israel. The book describes Saul's reign and then David's rise to the throne. The second book is a history of David's reign.

Most scholars believe that the Books of Samuel are a combination of at least two earlier works. The books do not simply tell stories about heroes and kings. They show that when the king obeys God's will, then the king and the nation prosper. If the king disobeys God, then he is punished and the kingdom suffers. See *Bible* (The Old Testament).

The Books of Samuel as we know them date from after the destruction of the kingdom of Judah in 587 or 586 B.C. After this defeat, the Hebrews had no king. They wanted to understand why God gave them a monarchy and why God took it away. Many Hebrews believed that their homeland would be restored to them and that they would have a chance to rebuild their nation. In the Books of Samuel, they tried to find lessons for the new nation in the history and experience of the past.

Samuel, Viscount (1870-1963), was a British Liberal statesman. He led the Liberals in the House of Lords from 1944 to 1955.

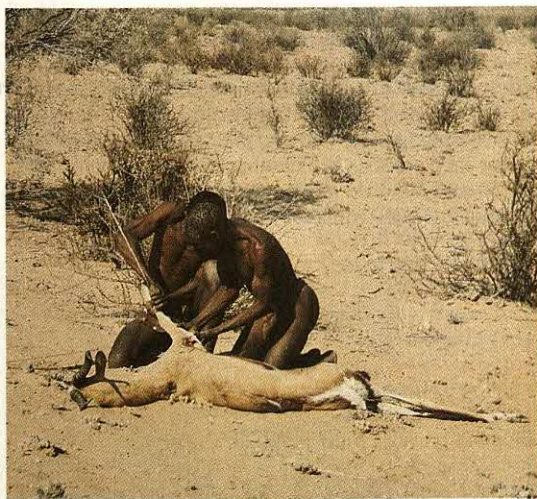
Herbert Louis Samuel was born in Liverpool and studied at Oxford University. He was elected member of Parliament for Cleveland in 1902. In 1909, he became chancellor of the Duchy of Lancaster, with a seat in the Cabinet. He was twice postmaster general, and was home secretary in 1916. From 1920 to 1925, he was high commissioner in Palestine. Samuel became home secretary in 1931. He was made a viscount in 1937.

Samurai was the hereditary warrior class in feudal Japan. The term originally referred only to the imperial guards. After the coming of a feudal system, it meant the entire military class. This included the samurai warriors, the feudal lords called *daimyos*, or *daimios*, and the shogun (see *Shogun*). About 5 of every 100 Japanese belonged to this group.

A code of unquestioning obedience and loyalty, called *Bushido*, bound the samurai warriors to their lords. The samurai prized honour above wealth or life, and atoned for dishonour by committing *hara-kiri*, or ceremonial suicide (see *Hara-kiri*). They wore two swords and a distinctive headdress. The samurai were graded in military ranks, each with an appropriate income in rice. They lost their privileges when the Japanese abolished feudalism in 1871.

See also *Judo* (History).

San are a people of Africa, most of whom live in the Kalahari Desert region of Botswana and Namibia. The San are sometimes called Bushmen, but many anthropologists consider the word an insulting term. Another



San hunters cut up the body of a springbok with an arrow-head, *above*. Some San still hunt animals with poisoned arrows.

name for the San, Basarwa, is used mainly in Botswana.

The San have yellowish-brown skin and tightly coiled black hair. Most adult San are about 1.5 metres tall. They speak *Khoisan* languages, which are characterized by clicking sounds.

In the past, the San hunted animals and gathered wild plants for food, much as prehistoric people did. Today, however, only a few San follow their traditional way of life. Much of the San's land has been taken over by other Africans, including many whites of European descent. Many San now live in permanent settlements, where many depend on welfare. Others work on cattle farms. Some have worked for the South African military.

Traditionally, San families lived in groups that averaged about 25 people. Each group occupied its own territory. During part of the year, the group moved from place to place within its territory. But at other times, the group stayed for many weeks near a water source with other groups. Group members built shelters of branches and grass.

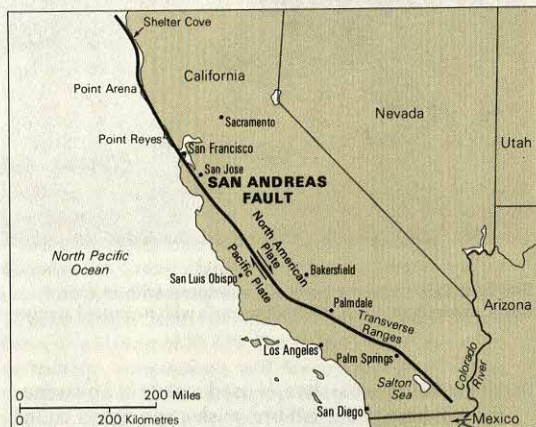
Wild desert plants provided the San with most of their food, which included berries, melons, nuts, roots, and seeds. The women usually gathered the plants while the men hunted animals with bows and poison-tipped arrows. After killing a large animal, the hunters would share the meat with the whole group. Anthropologists believe that even in the rugged Kalahari region, the San needed only about two hours a day to hunt and collect their food.

No one knows where the San first came from, but they lived throughout southern and eastern Africa for thousands of years. Bantu-speaking black tribes had moved into these regions by A.D. 300, and Europeans arrived in the 1600's. In time, no San remained in eastern Africa or in the richer lands of southern Africa. But they continued to live in the Kalahari Desert. In the mid-1980's, there were about 50,000 San.

See also *Africa* (picture: Botswana San); *Botswana*; *Religion* (picture: African San).

San Andreas Fault is a long fracture in the earth's crust marked by a zone of disrupted land in California. The fault extends about 970 kilometres from off the coast of northwestern California to the southeastern part of the state near the Mexican border.

According to the theory of *plate tectonics*, the earth's outer shell consists of a number of rigid plates that are in slow, continuous motion with respect to one another. During the past 15 million years, the San Andreas Fault



The San Andreas Fault is a fracture in the earth's crust that extends through much of California, U.S.A. Sudden crustal movements along the fault have resulted in severe earthquakes.

has formed part of the boundary between the Pacific Plate and the North American Plate. During this time, coastal California, along with the rest of the Pacific Plate, has moved about 300 kilometres in a northwesterly direction with respect to North America. Present-day movement along the San Andreas Fault averages 5 to 6 centimetres yearly. See *Earth* (diagram: The earth's plates).

The movement of the plates along the San Andreas Fault produces strain on the rocks near the plate boundary. Along some segments of the fault, the strain is released by frequent small earthquakes that do little damage. But along certain other segments of the fault, the plates are locked in place, and the strain builds up over many years.

The built-up strain occasionally produces a major earthquake. In 1857, a sudden movement along a segment of the San Andreas Fault in the Transverse Ranges caused a severe earthquake in southern California. In 1906, movement along another fault segment resulted in a major earthquake in San Francisco. In 1989, movement occurred again and caused yet another major earthquake. These two areas of the fault are locked and are likely to produce a major earthquake once every few hundred years.

See also *Earthquake*; *Plate tectonics*.

San Antonio, Texas (pop. 935,933), is one of the most historic cities of the United States. During its history, San Antonio has been under the control of Spain, Mexico, and the independent Republic of Texas. It has been called *Alamo City*, in honour of the famous Battle of the Alamo that was fought there in 1836.

San Antonio is one of the Southwest's leading cultural and trade centres. Some of the largest military bases in the United States are in the San Antonio area. The city lies on the rolling prairies of south-central Texas, about 240 kilometres northeast of the Mexican border.

Father Antonio Olivares founded San Antonio in 1718, when he established a Spanish mission at the site. The Spanish government chose this location because it wanted a settlement midway between its missions in eastern Texas and its military posts in northern Mexico. Members of an earlier Spanish expedition had named the site *San Antonio* after Saint Anthony of Padua.

About 92 per cent of San Antonio's people were born in the United States. More than half are of Mexican or Spanish descent, and much of the city's population speaks both English and Spanish. Other groups include people of English, French, German, Irish, Italian, or Polish ancestry. Blacks make up about 7 per cent of the population.

San Diego, California (pop. city, 1,110,549; metropolitan area, 2,498,016), is one of the chief naval and aerospace centres of the United States. It lies in the southwestern corner of the country, on the United States-Mexico border. The city covers 1,020 square kilometres, including 181 square kilometres of inland water. It is the seat of San Diego County.

San Diego has one of the finest natural deepwater harbours in the world. The harbour, which lies on San Diego Bay, serves ocean-going ships, tuna fleets, and United States Navy vessels.

The city is sometimes called *The Birthplace of California*. It was founded in 1769, when Spanish soldiers built California's first *presidio* (military fort) on the site. The Spaniards chose the location because of the fine harbour. That same year, a Franciscan priest, Junípero Serra, established California's first mission in the *presidio*. The settlement was named after San Diego de Alcalá, a Spanish saint.

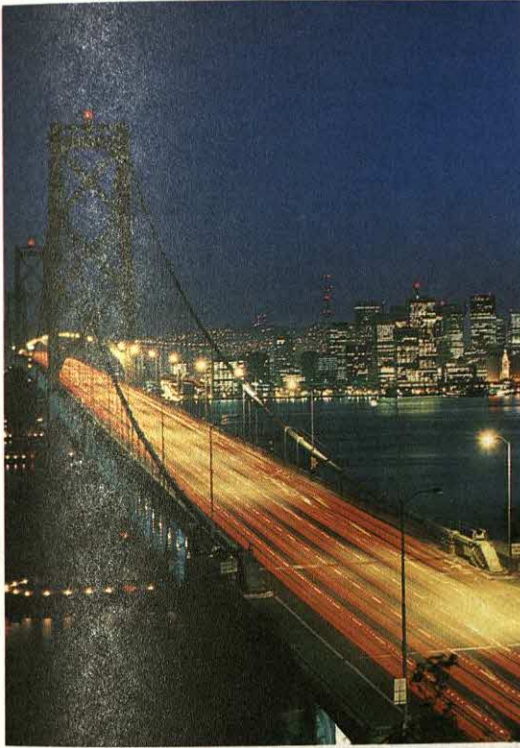
About 90 per cent of San Diego's residents were born in the United States. Hispanics—most of whom are Mexican Americans—make up about 21 per cent of the population. Blacks make up about 9 per cent. Other groups include people of British, Canadian, Chinese, German, Italian, Japanese, and Portuguese descent.

San Domingo, a variant of Santo Domingo. See *Santo Domingo*.

San Francisco, California, is one of the world's most interesting cities and a leading centre of culture, finance, and industry in the United States. Its clanging cable cars, fascinating Chinatown, and many hills give the city a special charm. San Francisco's scenic beauty and mild climate also have helped to win it a reputation as "America's favourite city." It attracts about 3 million tourists each year.

San Francisco is the third largest city on the Pacific Coast of the United States. Only Los Angeles and San Diego have more people. San Francisco has been called the "most Asian" city on the mainland of the United States because of its large Asian population. About 200,000 people of Chinese, Japanese, Philippine, Korean, Thai, and Vietnamese ancestry live in the city.

San Francisco is built on and around more than 40 hills. Some of the steepest streets in the world lie in San Francisco's central area on Nob Hill and Russian Hill.



San Francisco's city centre lies on San Francisco Bay. The San Francisco-Oakland Bay Bridge crosses the bay to the northeast of the city, and is 13 kilometres long.

These hills rise as much as 115 metres, and the cable cars and other vehicles seem almost to stand on end as they climb or descend the slopes.

City. San Francisco lies on the northern tip of a peninsula. The city covers 334 square kilometres, including 215 square kilometres of water, and occupies all of San Francisco County. San Francisco includes several islands in the Pacific Ocean and in San Francisco Bay. Alcatraz, the most famous, lies in the bay (see *Alcatraz*).

Many people consider San Francisco's climate to be ideal. The temperature rarely rises to 27° C or drops to -1° C. However, fog often covers the western part of the city. It forms when warm air flows over the cold ocean water. San Francisco occasionally has smog.

Two spectacular bridges link San Francisco to other parts of the Bay Area. The 13.0-kilometre San Francisco-Oakland Bay Bridge crosses the bay. The Golden Gate

Bridge connects the city and its northern suburbs. Its main section stretches 1,280 metres and is one of the world's longest spans.

People. Whites make up about 55 per cent of San Francisco's population. Asians and Pacific Islanders make up about 30 per cent. Blacks make up most of the remaining population.

San Francisco's white population includes people of many ethnic backgrounds. The largest groups are people of English, German, Irish, Italian, and Russian ancestry. The white population also includes many Mexican-Americans. Blacks make up San Francisco's largest single ethnic group. The city's black population began to climb during World War II (1939-1945), when thousands of blacks came from the South to seek jobs in the booming shipyards. People of Chinese ancestry make up the second largest single ethnic group. Many of the city's first Chinese came to work in the mines during the gold rush of 1849.

San Francisco, like other big U.S. cities, faces such problems as poverty, crime, and slums. The city's poor include Asians, blacks, elderly whites, and Spanish-speaking people. Most of them lack education and necessary job skills. These conditions contribute to the city's crime rate.

Some San Franciscans also lack decent housing. Urban renewal programmes have provided modern, low-cost flats and terraced houses for many poor San Franciscans. But other poor city residents still live in below standard housing.

Economy. San Francisco has long been one of the nation's leading financial centres. It is also a major centre of commerce, industry, and tourism.

San Francisco had the busiest port on the Pacific Coast during the 1800's. But several other ports in the Bay Area developed rapidly in the early 1900's. Today, the Port of San Francisco handles only about 2.5 million metric tons of cargo a year—far less than some other nearby ports.

About a fifth of San Francisco's workers are employed in retail and wholesale trade. Many of them work for firms that serve the tourist trade.

San Francisco has about 1,700 manufacturing plants. Garment making is the largest industry. Other important industries process food, produce electronic equipment, and make metal products. The city is also a leading printing and publishing centre.

San Francisco is also a major administrative centre for industrial firms. More than 100 large U.S. corporations have headquarters in or near the city.

San Francisco's cable cars run on rails and are pulled by a moving cable under the street. The cable car system, a national historic landmark, has three lines and covers 16 kilometres.

History. The Costanoan Indians lived in what is now the San Francisco area long before Europeans arrived. Fogs often lie along the Pacific Coast for weeks. Such fogs probably prevented early European navigators from finding the Golden Gate, the entrance to San Francisco Bay.

In 1769, Europeans finally reached the site of San Francisco by travelling overland. In 1848, gold was discovered near what is now Sacramento. The discovery led to the gold rush of 1849. Hundreds of ships, jammed

Facts in brief about San Francisco

Population: City—723,959. Metropolitan area—1,603,678.

Area: City—334 km², including 215 km² of water. Metropolitan area—3,287 km². Consolidated metropolitan area—20,616 km².

Climate: Average temperature—January, 10° C; July, 15° C. Average annual precipitation (rainfall, melted snow, and other forms of moisture)—56 cm.

Government: Mayor-council (for city and county combined). Terms—4 years for the mayor and the 11 members of the council, or Board of Supervisors.

Founded: 1776. Incorporated as a city in 1850.



Cable cars add to the charm of San Francisco. A crowded Hyde Street car carries passengers up Russian Hill, *above*.

with thousands of gold seekers, streamed into San Francisco's harbour. The fortune hunters, who came from all over the world, swept through San Francisco on the way to the gold fields.

Following the fabulous California gold strike, mining boom towns sprang up throughout the West. San Francisco became the centre of finance and supply for them.

San Francisco suffered one of the worst disasters in United States history when a severe earthquake shook the city at 5:13 a.m. on April 18, 1906. At least 3,000 people died in the disaster, and about 250,000 lost their homes. Most of the city, including more than 28,000 buildings, lay in ruins. Property damage exceeded 500 million U.S. dollars.

San Franciscans quickly rebuilt their city and its population grew steadily. By 1930, it had reached 634,394. The San Francisco-Oakland Bay Bridge opened in 1936, and the Golden Gate Bridge in 1937.

Increasing problems of citywide decay during the

1950's led to large urban renewal projects in the 1960's. Modern terraced houses and flats replaced slum housing in Hunters Point and the Western Addition. Towering new office buildings in central San Francisco created an impressive skyline overlooking the bay. The most ambitious project was the huge residential and commercial complex called Golden Gateway.

The building boom continued in the 1970's. By the 1980's, a debate had reached a peak about the benefits of the city's building boom. Some residents argued that skyscrapers destroyed the city's charm and beauty. In 1985, an ordinance called The Downtown Plan limited the size of future structures, preserved many existing buildings, and called for open spaces to relieve congestion.

On Oct. 17, 1989, a strong earthquake—though not as strong as the 1906 quake—struck San Francisco and the surrounding area. Some areas of the city, especially older ones, suffered severe damage. Others, especially newer areas where buildings had been constructed to withstand earthquakes, escaped major damage. About 10 people in San Francisco died as a result of the earthquake. The earthquake caused many more deaths across the bay, in Oakland, where a portion of the top level of a double-decked road fell onto the lower level.

Related articles in *World Book* include:

Alcatraz
Cable car

Gold rush
Golden Gate Bridge

San Francisco Conference. Delegates from the United Nations met in San Francisco on April 25, 1945, to form a world organization strong enough to prevent another global war. Representatives of the nations then winning World War II drew up the charter for the United Nations, providing a framework for further cooperation in time of peace.

After two months of work, the conference drew up the United Nations Charter. The delegates signed it on June 26, 1945. Each nation agreed to fulfil its obligations under the Charter, settle disputes peacefully, cooperate in police actions, and help solve world economic and social problems.

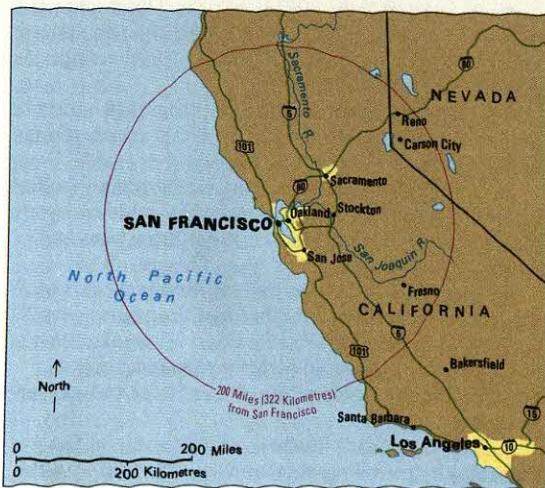
See also **United Nations** (The San Francisco Conference).

San Francisco-Oakland Bay Bridge is one of the longest bridges in the world over navigable water. It crosses San Francisco Bay in the United States between Oakland and San Francisco, California. The Bay Bridge is really a series of bridges. It is more than 13 kilometres long, including its two approaches. It carries two decks for traffic. It opened in 1936.

San Jose, California (pop. 782,248; met. area pop. 1,497,577), is a major industrial city in the United States and one of the nation's chief centres of aerospace manufacturing. It lies in the Santa Clara Valley, about 80 kilometres south of San Francisco.

The electronics industry's chief products are computers and related equipment. The area from San Jose northwest to Palo Alto is sometimes called Silicon Valley because of its many computer and related industries.

San José (pop. 241,464; met. area pop. 560,000) is the capital, largest city, and commercial centre of Costa Rica. It lies on a plateau in the main agricultural region of the country. For location, see **Costa Rica** (political map).



San Francisco is located on the Pacific Coast.

San José has a modern appearance and a mainly middle-class population. Important landmarks include the National Theatre and the National Museum. The National Theatre is an elaborately decorated centre for the performing arts built in 1897. The National Museum is housed in a fortress that dates back to 1832.

San José is the centre for trade in coffee, bananas, and sugar produced in Costa Rica. It has numerous factories that process foods and manufacture chemicals, textiles, and furniture. Railways link San José to ports on the Caribbean Sea and the Pacific Ocean. Juan Santamaría International Airport also serves the city.

Spanish settlers founded San José in the mid-1700's. During the 1980's, the population grew rapidly as a result of a steady flow of refugees from nearby war-torn countries.

See also **Costa Rica** (picture).

San Juan (pop. 434,849; met. area pop. 1,086,376) is the capital and largest city of Puerto Rico. It is also the island's chief seaport. The older part of the city lies on an island off the northern coast of Puerto Rico. Newer residential districts lie on the main island. Four bridges and a road have been built over the water to connect these sections.

Trade, manufacturing, and government are San Juan's chief activities. Some of the Spanish forts and the walls around the older part of the city are over 250 years old. San Juan National Historic Site, covering 19.53 hectares, contains many of these fortifications. Morro Castle, begun in 1539 and completed in the late 1700's, lies on a bluff at the entrance to the bay, one of the best harbours in the West Indies.

The Centre for Advanced Studies on Puerto Rico and the Caribbean and a campus of the University of Puerto Rico are in San Juan. Nearby Santurce is the home of the University of the Sacred Heart and the Conservatory of Music of Puerto Rico.

In 1521, followers of Ponce de León founded San Juan. It served as the seat of the Spanish provincial government.

See also **Puerto Rico** (pictures).

San Luis Potosí (pop. 489,238) is a farming and mining centre in central Mexico. The city stands 362 kilometres northwest of Mexico City. It is the capital of the state of San Luis Potosí. For the location of San Luis Potosí, see Mexico (political map).

Spanish-style churches, public buildings, and houses from the 1600's stand in San Luis Potosí. Many people work in nearby silver, lead, and gold mines. The city is an important air and rail centre. It stands on the road between Mexico City and Eagle Pass, Texas, U.S.A. Industries include an aircraft plant, flour mills, textile mills, tanneries, breweries, furniture factories, and metal refining and smelting plants.

San Marcos, University of, in Lima, Peru, is the oldest university in South America. It is also called the University of Lima. The school was founded in 1551 by King Charles I of Spain. Dominican friars supervised the university until 1571. During the 1600's and 1700's, the university was noted for its schools of law and medicine. The university was closed during the early 1800's and reopened in 1861. It became a government-supported institute in 1874. Today, it offers courses in dentistry, economics, education, journalism, law, linguistics, liter-

ature, medicine, pharmacy, science, and veterinary medicine.

San Marino is a small European country that is surrounded by Italy. It lies in the Apennine Mountains of northeastern Italy. Much of it—including its capital and largest city—stands on Mount Titano. The capital is also called San Marino. San Marino is one of the smallest countries in the world. It covers only 61 square kilometres.

San Marino is the oldest republic in the world. The country has been independent since the A.D. 300's. Its official name is *La Serenissima Repubblica di San Marino* (The Most Serene Republic of San Marino).

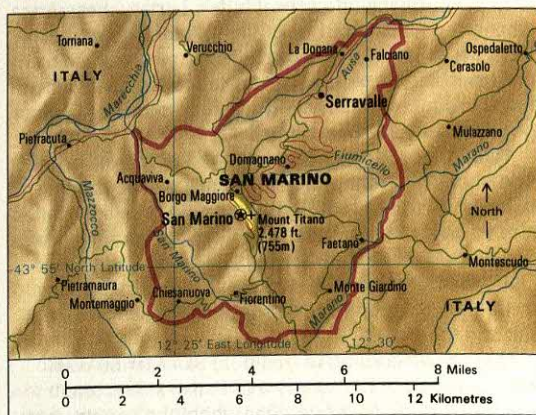
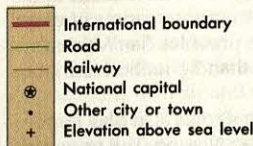
San Marino is a popular tourist centre. Visitors enjoy the country's spectacular views, fortress walls, cakes and wine, and colourful festivals. San Marino is also known for its beautiful postage stamps.

Government. San Marino is a republic. A legislature called the Grand and General Council makes the country's laws. The people elect the 60 council members to five-year terms. The council selects two of its members to head the government. These two officials, known as *captains-regent*, serve for six months and cannot be re-elected for three years. They appoint the heads of the 10 departments of the government. The captains-regent and department heads make up the Congress of the State. Twice a year, the heads of all the families in San Marino meet—as they have for centuries—to discuss public matters. Political parties in San Marino are generally similar to those in Italy and have the same names.

People. San Marino has about 23,000 people. They are closely related to the people of northern Italy. Nearly all San Marinese are Roman Catholics and speak Italian, and their customs are like those of Italy. However, the people of San Marino are proud of their long tradition of independence, and many of their holidays honour events in the nation's history.

Many of San Marino's people work in the tourist in-

San Marino



Facts in brief about San Marino

Capital: San Marino.

Official language: Italian.

Area: 61 km².

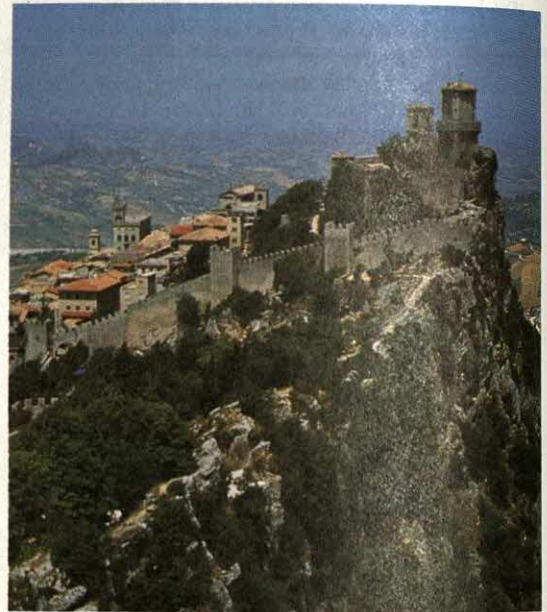
Elevation: *Highest*—Mount Titano, 755 m. *Lowest*—Ausa River at northern border, 50 m above sea level.

Population: *Estimated 1996 population*—23,000; density, 393 people per km²; distribution, 90 per cent urban, 10 per cent rural. *1976 census*—19,149. *Estimated 2001 population*—23,000.

Chief products: Barley, fruit and vegetables, wine, wheat, building stone, ceramics, leather goods, textiles, tiles, varnish.

Flag: The flag has a blue and a white horizontal stripe. The state flag, used by the government, has a coat of arms in the centre. The national flag, used by the people, does not have a coat of arms. See Flag (picture: Flags of Europe).

Money: *Currency unit*—Italian lira. One lira = 100 centesimi.



San Marino is one of the smallest countries in the world. Its picturesque capital, also called San Marino, *above*, lies on Mount Titano and is surrounded by a stone wall.

dustry, which includes hotels, restaurants, and souvenir shops. Other people work in stone quarries or make leather or cheese. San Marinese farmers rear cattle and sheep and grow such crops as grapes and wheat.

Nearly everyone in San Marino can read and write. The law requires children between the ages of 6 and 14 to attend school. After primary and secondary school, many students attend schools of higher education in Italy.

Most San Marinese homes have a telephone, radio, and television set. Films also are popular.

Land. San Marino lies in the rugged terrain of the eastern Apennine Mountains near the Adriatic Sea. Mount Titano, the country's highest mountain, is 755 metres high and has three peaks. On top of each peak is a tower built during the Middle Ages. The capital, San Marino, is near the top of the mountain. A road and a railway link the country with Rimini, the nearest Italian city. A helicopter service provides transportation to and from Rimini during the summer.

San Marino has a mild summer climate, with a temperature that averages about 24 °C. Winter temperatures sometimes fall below freezing. The country has an average annual rainfall of 89 centimetres. The soil in San Marino is poor and rocky. However, the mild climate and ample rainfall enable farmers to grow a variety of crops.

Economy. The tourist trade provides San Marino's chief source of income. More than 2½ million tourists visit the country yearly.

Farming and construction materials also play important roles in the economy of San Marino. The principal farm products include animal hides, barley, chestnuts, wheat, vegetables, and fruit. The fruit include grapes, from which wine is made. Building stone and lime from mountainside quarries are exported to Italy. Manufactured products of San Marino include ceramics, leather goods, tiles, varnish, and textiles.

Two other sources of income for San Marino are the sale of postage stamps and an annual payment from Italy. San Marinese postage stamps are prized by collectors throughout the world. The Italian government pays San Marino for certain privileges. These privileges include the right to tax San Marinese goods shipped through Italian ports and to supply all of San Marino's salt and tobacco.

History. According to tradition, San Marino was founded in the A.D. 300's by a Christian stonemason named Marinus. Marinus, after whom the country was

named, fled to Mount Titano to escape religious persecution by the Romans. An independent religious community had grown up in San Marino by 885, and a republic was established by the 1300's. During the next 200 years, the citizens of San Marino defended their republic against plots by, and attacks from, neighbouring states. In 1631, the independence of San Marino was recognized by the pope, who controlled the surrounding territory. Later popes opposed attempts by some Italian cardinals to take over the country.

The territory surrounding San Marino became part of the kingdom of Italy in 1861. San Marino and Italy signed a treaty of friendship in 1862. Renewed in 1877, this treaty has governed relations between the two countries since that time. During most of World War II (1939-1945), San Marino was officially neutral, but Fascists controlled the government. The British bombed the country once in 1944.

From 1945 to 1957, a coalition of Communists and Socialists held a majority of seats in the Grand and General Council. The Christian Democratic Party gained control of the council in 1957 and governed the country for the next 20 years. Since the elections of 1978, a coalition of Communists, Socialists, and others on the political left has usually held power.

San Marino (pop. 4,179) is the capital and largest community of the country of San Marino. It lies high on Mount Titano. The town developed during the Middle Ages and is surrounded by a high stone wall. The wall connects three towers, one of which stands on each of the three peaks of Mount Titano. The towers are symbols of the country and appear on its flag. From the towers, people can view the surrounding countryside and the Adriatic Sea, which lies 19 kilometres to the north-east.

San Marino has a church that dates from the 1300's, many old houses, and winding, cobblestoned streets. During the 1800's, the town hall and a church were built in the Gothic style of the Middle Ages, and the town wall was rebuilt. Most of the city's shops and offices are in Borgo Maggiore, a suburb 180 metres below the wall.

San Martín, José de (1778-1850) was an Argentine general who helped lead the struggle for independence in South America against Spain. He is Argentina's greatest hero.

San Martín was born at Yapeyú, near present-day Paso de los Libres, Argentina. When he was 7 or 8 years old, his parents returned to their homeland, Spain. San Martín became an army officer and served with Spanish forces for 22 years. He helped defend Spain against invading French forces of Napoleon Bonaparte from 1808 to 1811. Then San Martín resigned his commission and went to join Argentina's struggle for independence.



José de San Martín

In 1812, revolutionaries in Buenos Aires gave him command of a military unit. In 1816, under San Martín's leadership, Argentines declared their independence from Spain.

San Martín then joined forces with the Chilean patriot Bernardo O'Higgins. In January 1817, they led an army over a pass nearly 4,600 metres high in the Andes Mountains. The army appeared before the astonished Spaniards in Chile and won the Battle of Chacabuco near Santiago on February 12. The patriot army won a second victory at Maipú in north-central Chile in April 1818. This victory led to Chile's independence.

In 1820, San Martín led an army to Peru. He declared the country free in 1821. The next year, he met Simón Bolívar, another leader in the fight for South American independence. San Martín then left to Bolívar the task of winning formal recognition of Peru's independence.

Back home in Argentina, San Martín became discouraged by political disputes. He was also saddened by the death of his wife in 1823. In 1824, San Martín left for Europe, where he died.

See also **Flag** (pictures: Historical flags); **Peru** (The war of independence); **Argentina** (Independence; picture: José de San Martín); **Chile** (History).

San Pedro Sula (pop. 372,800) is the second largest city of Honduras. It stands on the banks of the Chamelecón River. For location, see **Honduras** (map). It is the centre of the banana and sugar-cane industries, and of trade for the northern and western interior. Industries include a brewery, a sugar mill, and the plants producing soap, candles, shoes, and cigarettes.

San Salvador (pop. 452,614) is the capital and largest city of El Salvador. The city, an important centre of commerce and culture, lies about 40 kilometres from the Pacific Ocean. For location, see **El Salvador** (political map).

San Salvador's chief products include chemicals, furniture, processed foods, and textiles. Highways connect the city with the rest of El Salvador. The Pan American

Highway links San Salvador to other Central American cities and to cities in Mexico and the United States. An international airport also serves San Salvador.

San Salvador was founded in 1525 about 40 kilometres north of where the city lies today. The site was later moved. An earthquake destroyed the city in 1854, and the people rebuilt it at its present location. In 1986, another major earthquake caused more than 1,000 deaths and widespread property damage.

During the 1980's, conflict between government troops and rebel forces in El Salvador developed into a civil war. Thousands of people fled the violence in rural areas of the country and settled in slums on the outskirts of San Salvador.

San Salvador Island. See **Bahamas**.

San Stefano, Treaty of. See **Berlin, Congress of; Bulgaria** (Turkish rule).

Sana (pop. 427,185) is the capital and largest city of Yemen. It lies in the western part of the country in a fertile district of a mountainous region. For the location of Sana, see the map in the **Yemen** article. The city is an economic, political, religious, and educational centre of Yemen.

Sana is shaped like a figure 8 and is surrounded by a high wall. The seven-storey Republican Palace, a government office building, stands at its centre. The city has about 50 *mosques* (Muslim houses of worship). Many of Sana's buildings are five to nine storeys tall and have white plaster decorations that look like lace against the reddish-brown brick walls. Most of Sana's people are employed as craftworkers, government officials, or labourers. Sana is an ancient city.

Sanatorium. See **Sanitarium**.

Sancho Panza. See **Don Quixote**.

Sand is a loose accumulation of tiny pieces of rocks or minerals that are larger than silt or clay but smaller than pebbles. Scientists define sand as grains that measure from 0.06 millimetre to 2.1 millimetres in diameter.

Most grains of sand once formed parts of solid rocks that have crumbled away. Rocks break and crumble by the process of *weathering*. For example, waves pounding against a coastline wear away rocks. When water freezes in the cracks of rocks, it can cause them to split apart. Rocks also may break down as a result of chemical reactions with air and water.

Sand is widely distributed over the earth. It lies at the bottom of the sea and many lakes. Large amounts of sand wash up from shallow sea bottoms onto beaches. Sand also rolls along the bottom of rivers and may be deposited by the rivers over lowland areas. In desert areas, sand covers vast stretches of land. Wind may pile up the sand in low hills called *dunes*.

Sand may be composed of many types of material. Quartz is the most common mineral in sand. But sand also may include other minerals, such as feldspar, and fragments of rocks. Some sand beaches are made up mostly of the mineral *calcite*, which comes from broken shells and coral. Black sand found in Hawaii and on other Pacific Islands consists of grains of *basalt* and *basaltic glass*, which are rocks formed from the hardened lava of volcanoes.

Sand has important industrial uses. Sand and gravel are mixed with cement to make concrete. Manufacturers use a pure form of quartz sand called *silica sand* to

make glass, abrasives, furnace linings, and scientific moulds. Some river deposits of sand called *placers* may also contain small amounts of such precious substances as gold, platinum, and diamonds.

Related articles in *World Book* include:

Beach	Loam
Desert	Sandstone
Dune	Sandstorm
Glass	Silica

Sand, George (1804-1876), was the pen name of Amantine-Aurore-Lucile Dupin, a French novelist of the 1800's. Her work was admired by the greatest writers of her time. After her death, Sand's writing went out of style, and she was remembered only for her shocking life style and her love affairs with the composer Frédéric Chopin and the poet Alfred de Musset. She defied social convention by smoking cigars and wearing men's clothes. Since the emergence of the women's movement in the mid-1900's, Sand's work has been rediscovered and she has attracted critical attention as a novelist and autobiographer.

Sand was born in Paris and grew up in the tiny village of Nohant. She went to Paris in 1831 to write. Her many works can be divided roughly into four periods. Her first works were novels of romantic passion, notably *Indiana* (1832), *Valentine* (1832), and *Lélia* (1833). These novels protest against the socially defined condition of women and reflect her own emotional desires and disappointments. They plead for a woman's right to sincere love and to lead her own life. Beginning about 1840, Sand expressed her concern with social problems in such novels as *Consuelo* (1842-1843). In the mid-1840's, she wrote original novels of life in the French provinces. These include *The Devil's Pond* (1846), *François the Waif* (1848), and *Little Fadette* (1849).



George Sand

Her later writings include two volumes of children's stories, *A Grandmother's Tales* (1873, 1876).

Sand was also a playwright, travel writer, and journalist. Today, her memoirs and correspondence are among her most interesting works, especially *The Story of My Life* (1854-1855).

Sand bar. See Ocean.

Sand dollar belongs to a group of marine animals called *echinoderms*. It lives slightly buried in the sand in shallow coastal waters. Its thin, circular body is about 5 to 10 centimetres wide. Its dried skeleton looks like a large, white coin. A living sand dollar resembles a fuzzy brown biscuit.

The bodies of many species of sand dollars contain slots or notches. Sand moves up through the slots when the animal buries itself. A sand dollar has many tiny, movable spines, which it uses to dig and crawl. The top surface of the body has small breathing structures arranged in the shape of flower petals that form a five-pointed star. A sand dollar's mouth is in the centre of the undersurface. The animal eats tiny aquatic organisms



A sand dollar has a thin, circular body.

that it finds among the sand grains or traps from the surrounding water.

A sand dollar releases eggs from small openings near the centre of the top of the body. The eggs develop into free-swimming larvae. The larvae eventually sink to the ocean floor and grow into the adult form.

Scientific classification. Sand dollars belong to the phylum Echinodermata, class Echinoidea.

See also Echinoderm.

Sand dunes consist of masses of sand picked up, moved, and dropped by winds to form hills or ridges. Sand dunes are normally found in desert regions where windblown sand covers large areas of land. These mounds, sometimes found in pairs are often used as landmarks by desert travellers.

Dunes are also found in nondesert areas such as Antarctica where the wind has deposited materials other than sand. Dunes of clay are found in Africa, Australia, and the United States.

Sand fly is a hairy, dark-brown insect that measures about 3 millimetres long. Female sand flies are active at night, and suck blood from human beings and animals. The *larvae* (young sand flies) live in moist places and feed on decaying plant and animal matter.

Several hundred kinds of sand flies thrive in the tropical and subtropical regions of the world. They transmit germs that cause such serious diseases as kala-azar and sand fly fever.

Moth flies are related to sand flies, but they do not suck blood. Their wings fold over the body like a roof. Biting midges are sometimes called sand flies. They have two wings that lie flat on the back when the insect rests. In spring and autumn, biting midges may appear in swarms. They rank among the smallest blood-sucking insects. Some biting midges are only about 1 millimetre long.

Scientific classification. Sand flies, moth flies, and biting midges are all in the true fly order, Diptera. Sand flies and moth flies belong to the family Psychodidae. Biting midges are in the family Ceratopogonidae.

Sand painting is the name for making pictures in sand. The Navajo Indians of the southwestern United States are noted for their sand painting, also called *dry painting*. The paintings form a part of many ceremonies, especially healing rites. Medicine men and medicine women usually make sand paintings on the floor of a *hogan* (earth-covered dwelling). They get coloured sands by grinding stones from nearby cliffs. Medicine men make the designs freehand and from memory, and destroy them after the ceremonies. Coloured sand paintings were made in Japan in the A.D. 600's, and in Eng-



Sand painting is part of the Navajo Indians' healing ceremonies. These medicine men are making a sand painting to cure a sick child. The child will sit in the centre of the design.

land and France during the 1700's and 1800's. See also **Folklore** (picture: Many religious ceremonies).

Sand verberna is a low summer annual with fragrant pink, white, or yellow flowers. The blossoms resemble those of the verberna, but the two plants are not related. There are about 25 species of sand verbenas, and all are native to western North America. The plants grow best in open, sunny places and in light soils. They are used for rock and seaside gardens. They adapt well to desert conditions.

Scientific classification. Sand verbenas belong to the four-o'clock family, Nyctaginaceae. They make up the genus *Abronia*. One species is *A. umbellata*.

Sandakan (pop. 73,815) is the largest city in Sabah, a state of Malaysia. It is on the island of Borneo, near the Sulu Sea, about 225 kilometres east of Kota Kinabalu (see **Borneo** [map]). Ships connect Sandakan with Australia, Indonesia, the Philippines, and Peninsular Malaysia. Rubber plantations and timber camps spread inland from the city. Sawmills and fisheries form Sandakan's largest industries.

Sandal. See **Shoe** (History).

Sandalwood is a scarce, valuable wood obtained from several related kinds of trees. These trees grow in southern India, Indonesia, some Pacific Islands, and Australia. Sandalwood has a fairly straight grain. The wood also has a fine structure and is so heavy that it will barely float in water. The **heartwood** (centre) has a yellowish-brown or orange colour.

Sandalwood trees are slow growing. They usually take 30 years before they



Sandalwood

reach a sufficient size for the wood to be used. The leaves are leathery and grow in pairs, opposite each other on the branch.

Sandalwood has a fragrant odour from the aromatic oil that the yellow heartwood contains. The oil is obtained from the wood and roots by steam distillation. The oil is used to make incense, perfumes, soaps, and candles. It also has medicinal properties and is used as a stimulant and antiseptic.

The light-coloured **sapwood** (outer wood) is used to make ornamental furniture, carved boxes, jewel cases, combs, fans, and walking sticks. The wood is burnt at Buddhist funerals. Powdered sandalwood is used to make Brahmin caste marks.

Scientific classification. Sandalwoods belong to the family Santalaceae. The principal species of sandalwood is *S. album* of eastern India.

Sandblasting is a method for engraving such materials as glass and granite or for cleaning metal and some buildings. Compressed air forces sand through a hose from the blasting machine. The sand acts as an abrasive to wear away scale on metal, dirt on stone buildings, or to smooth the surface of glass. Machines that have a rapidly rotating bladed wheel to hurl metal abrasives, particularly steel shot, are also used. Manufacturers prefer using this method because it is faster and also costs less.

See also **Glass** (How glass is decorated).

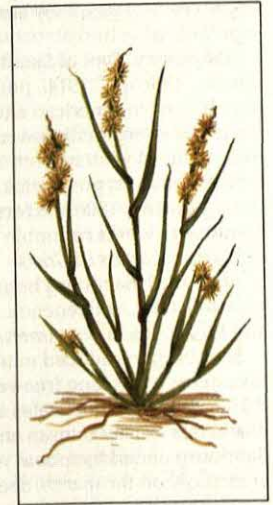
Sandbur, also called **bur grass**, is a troublesome prickly weed that originally grew on the plains of the Western United States. It is now found in sandy places in almost all temperate and tropical countries. A closely related species of plant is called the **cockspur**.

The stem of the plant grows from 30 to 60 centimetres high. It bears spikes with 10 to 20 shiny, sharp-spined burs that cause painful wounds when they prick the flesh. The seeds are dispersed by the burs becoming attached to an animal's fur.

There are about 20 related species of grasses in the drier parts of North America, Africa, and India. The grains of one species from the Sahara Desert region of Africa is collected and made into flour.

Scientific classification. Sandbur is in the grass family, Gramineae (Poaceae). Its several species belong to the genus *Cenchrus*.

Sandburg, Carl (1878-1967), was an American poet, biographer, and historian. Two major themes dominate his works. One is a search for the meaning of American history. The other involves his enthusiasm for the American common man. Quoting Rudyard Kipling, Carl Sandburg said of himself: "I will be the word of the people."



Sandbur

Mine will be the bleeding mouth from which the gag is snatched. I will say everything."

Sandburg was born in Galesburg, Illinois, U.S.A. He left school at the age of 13 and did odd jobs around Galesburg for several years. Sandburg described his boyhood in the small Midwestern town in his highly praised autobiography, *Always the Young Strangers* (1953).



Carl Sandburg

When he was about 18, Sandburg travelled throughout the Midwest as a tramp. After the Spanish-American War began in 1898, he served briefly in the United States Army in Puerto Rico. That same year, he returned to Galesburg, where he attended Lombard College. Sandburg left college in 1902 without graduating. For about 10 years, he was active in Socialist Party politics in Wisconsin.

Sandburg worked as a newspaper writer, primarily in Chicago, from 1912 to the late 1920's. He first won fame—for his poetry—during that period. Then the success of the first part of his great biography, *Abraham Lincoln*, enabled him to leave journalism and concentrate on a literary career. Sandburg was one of several important American writers who lived in Chicago from about 1912 to the mid-1920's. These writers included Sherwood Anderson, Theodore Dreiser, Ben Hecht, and Edgar Lee Masters. They are frequently called the *Chicago School*.

His poetry. One of Sandburg's best-known early poems, "Chicago" (1914), portrays the brutality and ugliness he saw in American cities. The poem also pays tribute to the energy and power of modern industry. In making the city his subject, Sandburg followed a tradition in American poetry that began with Walt Whitman during the mid-1800's. In form, style, and theme, many of Sandburg's works resemble the poems in Whitman's collection, *Leaves of Grass*.

After 1920, Sandburg began to collect American ballads, folk tales, and legends. He presented many ballads and folk songs in *The American Songbag* (1927).

Sandburg introduced much American folklore into his poetry. In his long free-verse poem *The People, Yes* (1936), he included tall tales about such fictional and real characters as Paul Bunyan and Christopher Columbus. Sandburg ended the poem with the American people vigorously on the march, seeking new forms of self-expression, and asking the questions, "Where to? What next?"

Sandburg believed deeply in the value of life, and he strongly opposed war. In his dramatic short poems "Grass" (1918) and "A.E.F." (1920), Sandburg protested against the folly and waste of war.

Some critics consider Sandburg's poetry crude and sentimental. But most agree that he accomplished his goal of being the voice of the American people and a spokesman for American democracy. His *Complete Poems* (1950) won the 1951 Pulitzer Prize for poetry.

His prose. To Sandburg, Abraham Lincoln repre-

sented all that was best in the American character. Sandburg also regarded the Civil War as the most important event in American history. From 1920 to 1939, he wrote six volumes of history about Lincoln and the Civil War. In *Abraham Lincoln: The Prairie Years* (two volumes, 1926), Sandburg dealt with Lincoln's career up to his election as President. Then, in *Abraham Lincoln: The War Years* (four volumes, 1939), Sandburg provided one of the fullest accounts of Lincoln's presidency ever written. For this work, Sandburg received the 1940 Pulitzer Prize for history. Many people rank this work as the finest historical biography of the 1900's.

Sandburg wrote three volumes of humorous stories for children—*Rootabaga Stories* (1922), *Rootabaga Pigions* (1923), and *Potato Face* (1930). He also wrote a historical novel, *Remembrance Rock* (1948).

Sanderling is a bird that belongs to the same family as the snipes and sandpipers. It differs from these birds by having only three toes. Sanderlings breed on Arctic beaches and tundra, and travel south in the winter.

The bird is about 20 centimetres long. Its feathers are hoary grey on the upper parts, and pure white beneath. It is a true beach bird and usually lives on seashores. Its favourite foods are small shellfish and marine insects that wash up with the tide. The female lays three or four eggs coloured a brownish-olive. The eggs are speckled with darker markings.

Scientific classification. The sanderling belongs to the snipe and sandpiper family, Scolopacidae. It is *Calidris alba*.

Sandglass. See Hourglass.

Sandhill crane. See Crane (with picture).

Sandinistas. See Nicaragua.

Sandpaper. See Woodworking (Sanding).

Sandpiper is a name given to a large number of birds. But the name usually refers to certain types of small birds with long, sensitive bills. These birds live on the seashore in all parts of the world, and many species build their nests north of the Arctic Circle.

Their plumage varies from buff to brown, grey, white, or black. The birds dig in the soft mud or sand, or probe among rocks, in search of insects, worms, shrimps, and soft molluscs. They often follow receding waves, sometimes in flocks, searching for bits of food. Their graceful movements and cheerful cries have made them popular birds. The female sandpiper lays three to four eggs. The eggs are coloured a light grey, buff, or olive, and spotted with dark brown.

The sandpiper family represents the largest family of shorebirds. Sandpipers are quick runners and they can wade in water and swim if necessary. Woodcocks and redshanks have even been seen transporting their young in flight, carrying them between their thighs.

Sandpipers are interesting also for their migratory habits. Those that breed in the farthest north tend to migrate farthest. One of the most widely travelled is the sharp-tailed sandpiper. It breeds in Siberia and winters in Australasia. On the wintering grounds, some species, such as red knots and dunlins, gather in mixed flocks numbering tens of thousands of birds.

The common sandpiper has a wide distribution throughout Europe and Asia. Habitats are the stony borders of lakes and estuaries and by rocky streams. It winters in Africa or Asia. The common sandpiper has a distinctive, musical high-pitched call.



Sandpipers are small wading birds that breed near water in the Northern Hemisphere, and overwinter on sand and mud shores.

Scientific classification. Sandpipers are in the sandpiper and snipe family, Scolopacidae. The common sandpiper is *Tringa hypoleuca*; the sharp-tailed sandpiper is *Calidris acuarinata*; the red knot is *C. canutus*; the dunlin is *C. alpina*. The Eurasian woodcock is *Scolopax rusticola*. The redshank is *Tringa totanus*.

See also **Godwit; Ruff; Snipe; Willet.**

Sandringham is a country estate used by the British Royal Family. It is in Norfolk, about 11 kilometres north-east of King's Lynn. The estate was acquired for Edward VII, then Prince of Wales, in 1861. Sandringham House was completed in 1870. The gardens were developed and improved by George V and Queen Mary. They may be toured by the public when the Royal Family is not in residence.

Sandstone is a type of rock composed chiefly of sand that has been "cemented" together by pressure or by minerals. The sand commonly consists of grains of quartz, feldspar, and other minerals. It may also include organic matter or rock fragments. The minerals that cement the grains include quartz, pyrite, or calcite. The colour of sandstone ranges from cream or grey to red, brown, or green, depending on the cements and impurities in the sand.

Sandstone was a common building material for larger structures before reinforced concrete came into use in the middle to late 1800's. Some great cathedrals in Europe were built of sandstone.

See also **Building stone; Quarrying; Sedimentary rock.**

Sandstorm is a storm in which the wind carries sand through the air. The wind-driven sand forms a low cloud above the ground. Most of the sand does not rise higher than 50 centimetres, but some grains rise about 2 metres. The grains carried by the wind average from 0.15 to 0.30 millimetre in diameter. During sandstorms, the wind reaches speeds of 16 kilometres per hour or more. The storms may last three to five hours.

Most sandstorms occur in the sandy areas of deserts. Some occur on beaches; dry riverbeds; or deposits of gravel, sand, and silt called *alluvial fans*. Sandstorms reduce visibility and thus endanger motorists on desert roads. They also damage crops.

During a sandstorm, most of the sand moves by a jumping or bouncing motion. When the wind gains speed, grains of sand roll forward and collide with other grains, causing many of them to bounce upward. Some of these grains fall and then bounce up again after striking a pebble or rock. Others become buried in patches of sand when they fall, but the impact forces still other grains into the air.

See also **Dust storm.**

Sandwell (pop. 282,000) is an industrial area in West Midlands, England. A local government district, it includes the towns of Oldbury, Rowley Regis, Smethwick, Tipton, Wednesbury, and West Bromwich. Local indus-



Sandringham is an estate in Norfolk, England. The Royal Family often spends Christmas there. Sandringham House, begun in 1861, was built in the Elizabethan style of architecture.

tries in Sandwell produce beer, boilers, chemicals, paint, pencils, processed food, and a wide variety of metal and engineering products. People living in the district played an important part in the Industrial Revolution of the 1700's and 1800's.

See also **West Midlands**.

Sandwich. See **Food** (table: Interesting facts).

Sang Nila Utama (? -1347?), a Malay prince, was the founder and first ruler of Singapore. His story is told in the *Malay Annals*, a book containing elements of myth, legend, and history, which was first compiled about 1520. According to the *Malay Annals*, Sang Nila Utama was the ruler of Palembang, in Sumatra. In 1299, he sailed to the island of *Temasek*, which means sea port. He and his men landed at Telok Blangah. When they travelled inland, they saw an animal, which they believed looked like a lion. Sang Nila Utama renamed the place *Singa pura* (lion city). There were no lions in Singapore. But the lion was a symbol of divine kingship, so by naming the place lion city, he signified that he was reestablishing the lion throne which he had set up in Palembang.

He ruled all Singapore for 48 years. He was buried on *Bukit Larang* (Forbidden Hill), which the British renamed Fort Canning in 1860.

Sanger, Frederick (1918-), a British biochemist, won the 1958 and 1980 Nobel Prizes in chemistry. He became the second person to receive two Nobel Prizes in the same field. The first was John Bardeen, who earned two Nobel Prizes in physics.

Sanger received the 1958 chemistry prize for developing a method of studying the structure of proteins. His research centred on insulin, the protein hormone that helps regulate carbohydrate metabolism. He shared the 1980 prize with Americans Paul Berg and Walter Gilbert. The three were honoured for their studies concerning the biochemistry of nucleic acids. Sanger was cited for developing a method of determining the chemical structure of large pieces of *deoxyribonucleic acid* (DNA), the substance that makes up genes.

Sanger was born at Rendcombe, in Gloucestershire, England. He did his research at Cambridge University and with Britain's Medical Research Council.

Sanger, Margaret (1883-1966), was the leader of the birth control movement in the United States during the early 1900's. At that time, it was illegal to distribute birth control information or devices in the United States. Sanger believed women should have economic and social equality with men. To achieve such equality, she thought women needed to avoid unwanted pregnancy. She founded what became the Planned Parenthood Federation of America, the nation's major birth control organization. Sanger originated the term *birth control*, which formerly had been called *voluntary motherhood*.

Sanger was born in Corning, New York, U.S.A. In 1912, she began to work as a nurse, caring for poor women in New York City. She saw the suffering caused to women by unwanted pregnancy. She joined the Socialist Party, became a feminist, and devoted her life to promoting birth control. In 1916, Sanger opened a birth control clinic, for which she was arrested and sent to prison. She eventually helped obtain passage of laws allowing doctors to give birth control advice.

See also **Birth control** (The birth control movement).

Sanhedrin was the highest national governing council of the Jews in Roman times. According to some scholars, there were two Sanhedrins. The 23 members of the political and civil Sanhedrin came mostly from among the Sadducees. The 70 members of the religious Sanhedrin, which was presided over by the high priest, came largely from among the Pharisees. Jesus was tried before the religious Sanhedrin. Saints Peter, John, Stephen, and Paul appeared before it on charges of religious error. After Rome put down a Jewish revolt in Palestine in A.D. 70, the council declined and completely disappeared. See also **Gamaliel**.

Sanitarium is a place where people go to improve their health. The word is sometimes used as another word for *sanatorium*.

A *sanatorium* is an establishment where sick people are treated. It is especially used for a place where a particular treatment is given.

Sanitation is a field of public health. It involves various efforts to control the environment to prevent and control disease. Sanitation also includes personal cleanliness, which helps protect against disease.

Many professions and various government agencies work together to protect the health of communities. Sanitary engineers work in designing and administering water treatment plants and sewage treatment plants. Government agencies establish and enforce laws that help promote a healthy environment. Sanitation activities include food processing and distribution, sewage treatment, solid waste disposal, water treatment, and numerous other measures, such as control of air pollution and rodents.

Food processing and distribution. Food and beverages can easily be contaminated by bacteria, viruses, worms, and other organisms and by chemical poisons. Government agencies are usually involved in food and beverage control. They inspect meat before and after animals are slaughtered. They also check the processing, labelling, packaging, and distribution of food. Legal requirements for producing, processing, and handling food are normally enforced by government health inspectors.

Sewage treatment. Sewage is water containing waste matter produced by people. It contains about a tenth of 1 per cent solid waste. It comes from sinks and toilets in homes, farms, restaurants, factories, and office buildings. Much industrial sewage contains harmful chemicals and other waste materials.

Sewage must be treated before it flows from sewerage systems into lakes, rivers, seas, and other bodies of water. Untreated sewage contaminates the water and, in time, can kill fish and aquatic plants. The sewage makes the water unsafe to drink and can also prevent use of the water for swimming, fishing, and other recreation.

Most cities and towns have at least one sewage treatment plant. In many rural areas, homeowners must provide their own sewage treatment. Most do so with large underground containers called *septic tanks*. For more information on sewage treatment, see **Sewage**.

Solid waste disposal has become a major sanitation problem. Solid waste, which is also called *refuse*, consists of rubbish from cities and towns, plus by-products of farming, mining, and manufacturing. Such by-products include animal carcasses and manure from

farms, sawdust and scrap metal from factories, and pieces of coal and various metals from mines.

Almost all methods of solid waste disposal can create environmental problems. For example, open dumps look unpleasant and may smell. They also harbour animals that carry disease. Burning solid waste causes smoke, which pollutes the air. But when land disposal sites and incinerators are properly operated, they cause little harm to the environment. See **Waste disposal**.

Water treatment. Most water must be treated before it is used for drinking, cooking, bathing, or laundering. Almost all untreated water contains bacteria, viruses, and other tiny organisms. It also may have an unpleasant odour and taste and contain minerals that make the water less useful as a cleaning agent.

Cities and towns obtain water from one of two sources: (1) the ground or (2) rivers and lakes. Water from rivers and lakes is piped from its source to a treatment plant, where chemical and physical processes purify it. Pipes under the streets distribute the water to houses and other buildings.

Other sanitation activities. Most communities have regulations that require dwellings, factories, hospitals, and recreation areas to meet certain sanitary standards. Sanitation also includes insect and rodent control, noise control, and licensing of operators of public facilities.

See also **Environmental pollution; Water** (City water systems).

Sansevieria is the name of 50 species of fleshy-leaved plants related to agaves (see **Agave**). One species, known as *mother-in-law's tongue*, is a popular house plant. It has spiky leaves, about 45 centimetres long, with golden yellow margins. Sansevierias grow in dry, tropical regions of Africa, Madagascar, and southern Asia. The leaves of some species provide fibres that are made into shoes, fishing nets, ropes, and sails.

Scientific classification. Sansevierias belong to the family Agavaceae, genus *Sansevieria*. Mother-in-law's tongue is *S. trifasciata*.

Sanskrit language is the oldest literary language of India and the basis of many modern Indian languages, including Hindi and Urdu. Its earliest dialect form, Vedic, was spoken by the Aryans, a people who invaded India from central Asia about 1500 B.C.

Sanskrit died out as a living language by about 100 B.C. However, Sanskrit continued, like Latin in the West, as a language of courtly poetry and drama. It also served as the learned language for science, philosophy, and religious texts. Even today, some scholars in India teach, speak, and write in Sanskrit.

The name *Sanskrit* means *refined* or *polished*. The term contrasts with the designation *Prakrit*, meaning *common* or *vulgar*, which is applied to the popular languages that developed from Sanskrit over a period of several hundred years. These languages, in turn, are the source of such modern languages of India as Bengali, Hindi, and Punjabi.

Sanskrit contains a rich selection of sounds. The language has 10 simple vowels and 4 *diphthongs* (paired vowel sounds pronounced as a single syllable). It also has 25 basic consonants, 4 *semivowels* (letters, such as *y*, that sound like vowels but take the place of consonants), and 3 *sibilants*, which produce hissing sounds. In addition, it has two breathing sounds, and a nasalizing

० काकौ वृक्षे वसतः १ देवो वदति
२ किमर्थम्यत्तरम्युचो न स्मरति

Sanskrit is the classical language of Hindu religion and culture. Translated, these Sanskrit sentences mean: (a) Two crows dwell in a tree; (b) The God speaks; (c) Why does the son not remember the father?

sound. Sanskrit has a complex grammar. For example, nouns and adjectives have three genders (masculine, feminine, and neuter). They are inflected for three grammatical numbers (singular, dual, and plural). They also have eight cases (nominative, accusative, instrumental, dative, ablative, genitive, locative, and vocative). The verbal system is equally complex. Sanskrit belongs to the Indo-Iranian branch of the Indo-European language family.

See also **Sanskrit literature; India** (Languages); **Aryans**.

Sanskrit literature is the literature of India written in the ancient language called Sanskrit. The literature falls into three periods—Vedic, Epic, and Classical.

The Vedic period extended from about 1400 to 500 B.C. Vedic literature is essentially religious and concerns the solemn and domestic rituals of the early Aryan civilization of India. The oldest of these works are three related Vedas—*Rigveda*, *Samaveda*, and *Yajurveda*. A fourth Veda is called the *Atharvaveda*. The Vedas are anthologies of texts in verse that provided the liturgies for the holiest rites of the early Indian religion. Attached to the Vedas are later texts, including the *Brahmanas* and the *Upanishads*. The *Brahmanas* are long prose works that explain the mythological and theological significance of these rites. The *Upanishads* emphasize inward reflection and search for unity in existence. The *Upanishads* gave birth to Indian philosophy.

As the Vedic period ended, the old religion was threatened by new religious movements. A vast body of literature arose to preserve the ancient texts and rituals in unchanged form. This literature included manuals for ritual performance and books on such subjects as grammar, astronomy, and mathematics. These texts reflect the development of the scientific method in ancient India.

The Epic period overlapped the Vedic and Classical periods and covered the years of composition of India's two great epic poems, the *Mahabharata* and the *Ramayana*. Both were probably begun in about 500 B.C. or earlier. Since then they have grown in size and form. The most famous section of the *Mahabharata* is a philosophical dialogue called the *Bhagavad-Gita*.

The Classical period begins with the grammarian Panini in the 400's B.C. Panini described the Sanskrit he spoke in a set of about 4,000 rules. His grammar became the basis for all Sanskrit usage by later cultured writers. The oldest surviving works in Classical Sanskrit are the plays and poems of the Buddhist author Asvaghosa, who lived about A.D. 100, and the plays of Bhasa, who lived about A.D. 300.

The finest writer in the Classical style was Kalidasa, a poet during the Gupta dynasty, which reigned from about 320 to 500. His refined and elegant Sanskrit works remained unsurpassed. Kalidasa's talent is best seen in the lyric poem *The Cloud Messenger*. He also com-

posed dramas and epic poems. The first Sanskrit novel was *The Tale of the Ten Princes* by Dandin, who may have lived in the 600's.

Related articles in *World Book* include:

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Hindi	Upanishads
	Vedas

Santa Ana (pop. 135,186) is the second largest city in El Salvador. It is an important commercial centre, especially for the export of coffee. Other important industrial activities in Santa Ana include sugar milling, brewing, and the manufacture of cotton textiles, footwear, and furniture. Santa Ana also has a national theatre and an art school. For location, see El Salvador (political map).

Santa Anna, Antonio López de (1794-1876), was a Mexican soldier and politician. He was president of Mexico 11 times and often ruled as a dictator, but he was always overthrown.

Young soldier. Santa Anna was born in Jalapa, in the province of Veracruz, on Feb. 21, 1794. He began his long career by fighting with the Spanish army against the Mexicans in the War of Independence. Toward the end of the war, he deserted the Spaniards and joined forces with Agustín de Iturbide, who won and declared himself emperor of Mexico.

Santa Anna expected the new emperor to make him governor of Veracruz. When Iturbide failed to do so, Santa Anna led a revolt against him and drove him from power. In 1829, Spain attempted to reconquer Mexico. Santa Anna, as commander in chief of the Mexican Army, won several victories, and the Spanish invasion was defeated. He was elected president in 1833 but did not serve. In 1834, he joined a revolt against the acting government, took control of the country, and assumed

dictatorial powers.

War with Texas. Santa Anna abolished the federal constitution and placed the governors of provinces under his own control. These acts caused a revolt in Texas, a part of Mexico which had been settled by people from the United States. Santa Anna put down the revolt in San Antonio and the Alamo in 1836 (see *Alamo*). Then he met the main Texan army at San Jacinto. Santa Anna's army was routed, and he was taken prisoner. The Texans forced Santa Anna to sign a treaty acknowledging the independence of Texas. But the treaty was rejected in Mexico City, and Santa Anna was removed from power.

The American war. In 1838, the French attacked Veracruz. Santa Anna took command of the defending troops and beat back the attackers. From 1841 to 1844, he was president of Mexico again. In 1844, there was a revolt against him, and he fled to Jamaica. War broke out with the United States in 1846. Santa Anna returned to Mexico and took command of the army, but the American forces defeated him and Santa Anna left Mexico for several years.

In 1853, he returned to Mexico and became president again. He declared himself president for life, but within two years was again overthrown and exiled. He tried to return during the French invasion of Mexico in 1864, but was not allowed to enter the country. He returned in 1874 after the death of President Benito Juárez, and died in poverty in Mexico City.

See also *Mexican War*.

Santa Claus, also known as Father Christmas, is a legendary old man who brings gifts to children at Christmas. He has long been portrayed as a stout, bearded man in a red, fur-trimmed suit.

The idea of Santa Claus developed from stories about a real person named Saint Nicholas. Historians know little for certain about him. He probably was born in Patara, in what is now Turkey. When he was 19 years old, Nicholas became a priest. He later served as bishop of Myra, near Patara, and he died during the A.D. 300's.

According to legend, Saint Nicholas once aided a poor nobleman whose three daughters could not marry because they had no money. Saint Nicholas threw three bags of money into the nobleman's house so the daughters were able to marry. The legend of Saint Nicholas as a man who brings gifts may have developed from this story.

How the Santa Claus legend began. The custom of giving gifts on a special day in winter was practised before Christianity was founded. After Christianity was well established, Saint Nicholas became a symbol of the custom among Christians. During the Reformation of the 1500's, Protestants substituted nonreligious characters for Saint Nicholas. In England, for example, Saint Nicholas was replaced by *Father Christmas*. This character was called *Père Noël* in France and *Weihnachtsmann* in Germany.

The people of the Netherlands were especially fond of Saint Nicholas. The first Dutch settlers who went to America maintained their custom of celebrating the saint's feast day on December 6. They told their children that the saint visited their homes and left gifts on Saint Nicholas Eve. In time, English settlers adopted the legends and festivities associated with Saint Nicholas.



Oil portrait (about 1858) by Paul L'Ouvrier; The New York Historical Society, New York City

Santa Anna, a Mexican general, ruled Mexico as president 11 times during the 1800's but was overthrown each time.



Santa Claus was popularized as a jolly fat man driving a sleigh in a series of drawings by the American cartoonist Thomas Nast.

English-speaking children spoke the Dutch name for the saint, *Sinterklaas*, quickly and excitedly so that it sounded like *Santy Claus* or *Santa Claus*.

Santa's appearance. Until the 1800's, people pictured Saint Nicholas as a tall, thin, stately man who wore bishop's robes and rode a white horse. In 1809, the American author Washington Irving published *Knickerbocker's History of New York*, in which he presented a new version of the saint. Irving described Saint Nicholas as a stout, jolly man who wore a broad-brimmed hat and huge breeches and smoked a long pipe. Irving's Saint Nicholas rode over treetops in a wagon and filled children's stockings with presents.

On Dec. 23, 1823, a poem entitled "An Account of a Visit from St. Nicholas" appeared in the *Troy Sentinel* in New York. This poem begins with the familiar line "Twas the night before Christmas." Clement Clarke Moore, an American scholar, is generally credited with writing the poem, but Henry Livingston, an American land surveyor, may have written it. In the poem, Saint Nicholas appears as a stout, jolly man with twinkling eyes and a red nose. He wears a suit trimmed with white fur and rides a sleigh pulled by eight reindeer. The saint's visit takes place on Christmas Eve. See **Moore, Clement Clarke**.

Santalike characters in other countries. In the Netherlands and Belgium, Saint Nicholas visits homes on Saint Nicholas Eve, December 5. He leaves small gifts in shoes that the children put near the fireplace. He often is accompanied on these visits by a character named Black Pete, who carries a birch rod to whip naughty children. People in Austria, Hungary, and parts of Germany also celebrate Saint Nicholas Eve.

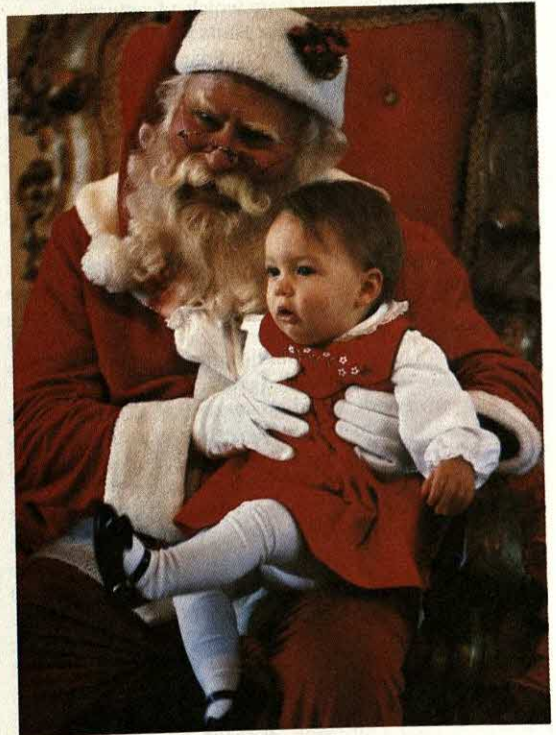
In southern Germany, people usually say that the *Christkind* (Christ child) sends the gifts on Christmas Eve. But in northern Germany, most people say the *Weihnachtsmann* (Christmas Man) brings the presents. From the name Christkind came the character *Kris Kringle*, the angellike figure who brings gifts at Christmas in the United States. In France, Père Noël leaves small presents in homes on Christmas Eve. In Sweden, the *Jultomten*, an elflike character, brings gifts to children on Christmas Eve. This elf is called *Julenissen* in Denmark and Norway.

See also **Christmas** (with pictures); **Nicholas, Saint**. **Santa Fe** (pop. 441,982) is a commercial and shipping centre in east-central Argentina. It lies on the west bank of the Paraná River at the mouth of the Salado River (see **Argentina** [political map]). The city is the capital of the province of Santa Fe.

Settlers from Asunción, in what is now Paraguay, founded Santa Fe near its present site in 1573. But the present site of Santa Fe was not permanently occupied until 1651.

Santa Fe, New Mexico (pop. 55,859), is the capital of the state and a major tourist centre of the Southwest United States. The charm of the city's adobe houses and narrow, winding streets helps attract large numbers of visitors.

Santa Fe has been a seat of government longer than any other state capital. It was founded in 1609 or 1610 as the capital of the Spanish colony of New Mexico. The city lies about 2,100 metres above sea level. It is the highest state capital in the United States.



Santa Claus has traditionally been portrayed as a stout, jolly man with a white beard and wearing a red suit with white fur.

Santa Fe Trail was one of the longest commercial routes in the United States in the prerailway era. It began in Independence, Missouri, and ended in Santa Fe, New Mexico, a distance of 1,260 kilometres. Caravans of traders travelled to Council Grove, Kansas, and on to the Cimarron Crossing of the Arkansas River near Cimarron, Kansas. There the route divided. One branch led up the Arkansas River to Bent's Fort (near La Junta, Colorado), then turned southwest across Raton Pass to the upper Canadian River in New Mexico. The other route cut across the Cimarron Desert. This one was shorter, but the risk of attacks by Indians made it more dangerous.

The early travellers transported their goods by pack horses. William Becknell opened the Santa Fe Trail in 1821. After that, traders took wagons loaded with manufactured goods to Santa Fe to exchange for mules, furs, gold, and silver. Between 1822 and 1843, an average of about 80 wagons and 150 people used the trail each year. Travel westward increased greatly in the 1850's and 1860's. By the late 1860's, more than 5,000 wagons a year used the trail. An extension of the trail, known as *The Old Spanish Trail*, ran from Santa Fe to Los Angeles by way of Durango, Colorado, the Green and Virgin rivers in Utah, the Colorado River, and across the Mojave Desert in California.

Santa Isabel. See **Malabo**.

Santa Maria. See **Columbus, Christopher** (First voyage westward); **Caravel**.

Santa Marta (pop. 218,205) is a seaport near the northern tip of Colombia. For location, see **Colombia** (map). The city is important as a banana-shipping centre. Many years ago it was the point from which adventurers started in search of El Dorado. Santa Marta was founded in 1525 by Rodrigo de Bastidas, a Spanish navigator and explorer. It is the oldest permanent settlement in South America. Nearby is the *hacienda* (estate) of San Pedro Alejandrino, where the South American liberator Simón Bolívar spent his last days before his death in 1830.

See also **El Dorado**.

Santayana, George (1863-1952), was a philosopher and author. He was born in Spain but grew up in the United States and spent about half his life there. He expressed his philosophy in technical works as well as in dialogues, literary essays, sonnets, and a novel, *The Last Puritan* (1936).

Santayana's philosophy puzzles many readers. He developed a theory of reality that centred on the distinction between *essences* and *existence*. Santayana defined essences as ideas, meanings, perceptions, and possibilities. In contrast, the world of existence includes the events, people, and things that we encounter in life. Santayana believed that not all essences actually exist, but that every existing thing includes essences. The role of essences, according to Santayana, is to describe and illuminate existence.

Santayana regarded religion as a kind of poetry expressing imaginative ideals that give spiritual meaning to life. But he said religion must not be taken literally. He wrote that people must believe in an ideal world where the human spirit can be creative and free. But this ideal world must not be mistaken for reality.

Santayana wrote an enormous number of works on art, morality, religion, and science. His *Three Philosophi-*

cal Poets (1910) consists of interpretations of Dante Alighieri, Lucretius, and Johann Wolfgang von Goethe. His *Character and Opinion in the United States* (1920) is a commentary on American life. Santayana's other well-known books include *The Sense of Beauty* (1896), *Interpretations of Religion and Poetry* (1900), *The Life of Reason* (five volumes, 1905-1906), *Scepticism and Animal Faith* (1923), and *Realms of Being* (four volumes, 1927-1940).

Santayana was born in Madrid. His family moved to the United States in 1872 and settled in Boston. Santayana graduated from Harvard University in 1886. He taught philosophy at Harvard from 1889 to 1912, when he settled permanently in Europe.

Santiago (pop. 4,385,481) is the capital and largest city of Chile. It is the nation's cultural, economic, and transportation centre. Santiago lies in the centre of Chile, about 144 kilometres east of the Pacific Ocean (see **Chile** (political map)). The promise of rich farmland and mineral deposits first attracted settlers to the area during the 1500's. Today, Santiago is an attractive city characterized by colonial architecture, wide boulevards, and hillside parks.

The city covers about 302 square kilometres. Santiago lies in the fertile Central Valley, the agricultural heartland of Chile. Mountains and hills surround the city. The Andes Mountains, the highest range in South America, rise above Santiago to the east. Many of these peaks remain snow-capped throughout the year, adding to the city's beauty. The Pacific coastal range forms Santiago's western border.

A square called the Plaza de Armas forms the heart of Santiago. The Cathedral of Santiago, City Hall, and many shops stand on the plaza. Several federal government buildings are nearby. Monuments and public buildings line a wide tree-lined avenue called the Avenida Bernardo O'Higgins. The Biblioteca Nacional in Santiago, South America's largest library, owns more than 1,200,000 volumes. Other attractions include the Civic Centre, the Museum of Natural History, and the Municipal Theatre, the home of Santiago's two symphony orchestras. The Catholic University of Chile, the Technical University, and the University of Chile are also in Santiago. Parks landscaped with gardens and memorial statues dot the city's hillsides.

People. Most of Santiago's people have Spanish ancestry, though some are of French, German, or Italian descent. Many of the people are *mestizos* (people of mixed white and Indian ancestry). About 95 per cent of the city's population are Roman Catholics.

The people of Santiago live and dress much like city dwellers in other Western countries. Wealthy and middle-class families live in spacious homes with landscaped courtyards in suburban areas. Their meals often feature such seafood as eels, shrimps, swordfish, or tuna, and they usually serve wine.

At least a quarter of Santiago's population live in poverty. A large number of them live in shanty towns called *callampas*, and their meals are based on beans, bread, and vegetables. Many of these people suffer from various illnesses because they lack adequate food and housing.

Economy. Santiago is the home of Chile's stock exchange and major banks. The government-owned rail-



Santiago, the capital and largest city of Chile, lies in the nation's agricultural heartland. The city is Chile's cultural, economic, and transportation centre.

way system and parts of the coal, copper, and steel industries have their headquarters in the city. Many of the people work for the federal or city government. Others work in factories that manufacture household appliances, textiles, or other products.

Santiago is the centre of the Chilean railway network, which covers about two-thirds of the country. Buses and trams, and an underground railway system provide local public transportation.

History. Araucanian Indians lived in what is now the Santiago area when Europeans arrived there in the early 1500's. A Spanish soldier named Pedro de Valdivia founded Santiago in 1541. It was the first permanent Spanish settlement in what is now Chile. In the late 1500's, Santiago became the seat of Spanish rule over the Chilean region and parts of Argentina. Santiago became the capital of Chile in 1818, the year in which the nation gained independence.

In 1879, Chile won lands rich in copper and nitrates by defeating Bolivia and Peru in the War of the Pacific. Santiago grew rapidly as a result of this new mineral wealth. By the early 1900's, the city had about a million people and was a cultural centre of Latin America. Santiago's economy expanded during World War I (1914-1918) because of the demand for nitrates used in making explosives. After World War II ended in 1945, Santiago became a centre of Chile's industrial expansion. The population of the city grew about twice as fast as that of the rest of Chile.

The METRO, Santiago's new underground system,

was completed around 1980. Since then, much construction of public housing and commercial high-rise buildings has further expanded the city.

Santiago (pop. 278,638) is the second largest city of the Dominican Republic. Only Santo Domingo has more people. The city's full name is Santiago de los Caballeros (Spanish for St. James of the Gentlemen). Santiago lies on the Yaque del Norte River in the northern part of the country (see **Dominican Republic** [map]). Santiago is a distribution centre for farm products, including cacao, coffee, fruits, sugar cane, and tobacco. The city's manufactured products include cigars, cigarettes, dolls, and clothing.

Santiago was founded about 1500 by Spanish explorers led by Bartholomew Columbus (a brother of Christopher Columbus). The city suffered extensive damage from earthquakes in 1564 and 1842, and from a fire in 1863.

Santiago de Cuba (pop. 345,772) lies at the foot of the Sierra Maestra range on the southeast coast of Cuba. It is 740 kilometres southeast of Havana. For location, see **Cuba** (political map). Santiago serves as the centre of Cuba's mining industry. It is a shipping centre for iron, manganese, sugar, coffee, and tobacco. Morro Castle, one of its landmarks, was built to defend its harbour from British and French pirates. In 1898, during the Spanish-American War, a United States fleet destroyed most of the Spanish fleet near Santiago harbour.

Santo Domingo (pop. 1,313,172) is the capital and largest city of the Dominican Republic. It lies at the



Santo Domingo, left, capital of the Dominican Republic, lies at the mouth of the Ozama River, on its western bank. Modern buildings in the background contrast with the riverside hovels that house the city's poor.

mouth of the Ozama River on the southern coast. For location, see **Dominican Republic** (map). The city is an important seaport and airport. Its factories produce sugar products, textiles, and alcoholic drinks. Resort hotels and beaches make it a popular tourist spot.

Santo Domingo is the oldest European-founded city in the Western Hemisphere. Bartholomew Columbus, a brother of Christopher Columbus, founded it in 1496 as *Nueva Isabela*. The Cathedral of Santo Domingo, completed about 1540, is the oldest church in the West Indies. Some historians say it holds Christopher Columbus' tomb.

A hurricane destroyed most of the city in 1930. It was rebuilt along modern lines, but many of its buildings are in the Spanish colonial style. An impressive example is the Alcazar, the rebuilt palace of Viceroy Diego Columbus, Christopher's son. From 1936 to 1961, under dictator Rafael Trujillo, the city was called Ciudad Trujillo. Santo Domingo faces problems of overcrowding. Its population has doubled since 1970. Many poor people from the countryside have moved to the city.

See also **Dominican Republic** (picture).

Santo Domingo, University of, in Santo Domingo, Dominican Republic, is the oldest university in the Western Hemisphere. It was established by Pope Paul III in 1538 as the University of Saint Thomas Aquinas. The Dominican Order of Preachers operated the school, granting degrees to lay students as well as the clergy. The university became a lay institution in 1815.

Santos (pop. 411,023) is the major port city of Brazil. It lies on Brazil's southeast coast, about 40 kilometres from the huge city of São Paulo. For location, see **Brazil** (political map). Santos is built on a small island that is linked by bridges to the mainland. The production of iron and steel, petroleum products, and hydroelectric power contribute to the city's economy. Many of the people who live in Santos work in São Paulo.

Portuguese colonists formed a settlement at the present site of Santos in the early 1500's. Santos became a town in 1586. In the 1860's, a railway was built between Santos and São Paulo. The railway helped Santos become a trading centre.

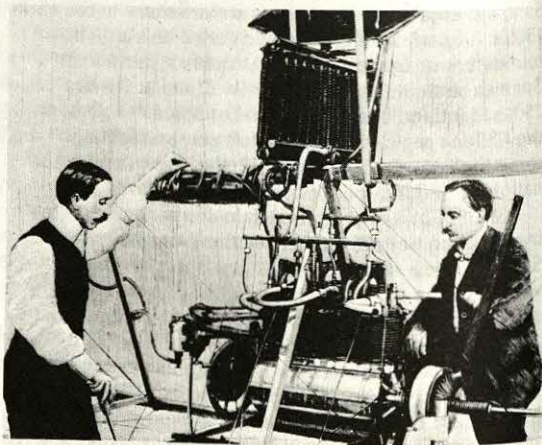
Santos-Dumont, Alberto (1873-1932), was an aviation pioneer in both lighter-than-air and heavier-than-air machines. He used his wealth to promote aviation and to help promising inventors.

Santos-Dumont was born in Brazil of wealthy parents, and was educated mostly in France. In 1898, he flew a cigar-shaped gas bag propelled by two small engines driving a single propeller. He built a box-kite aeroplane in 1905. Each wing was a box-kite, and a third box-kite was suspended ahead of the aircraft to provide control. In 1906, he flew it for eight seconds in the first heavier-than-air flight in France. The main advantage of his construction was its light weight, about half that of the first Wright brothers' biplane. One of his most lasting contributions was the use of wheeled undercarriages.

See also **Aeroplane** (Other pioneer planes and fliers; picture: The Demoiselle).

Sanzio, Raffaello. See **Raphael**.

São Francisco, River, is in eastern Brazil. It is also called San Francisco River or Rio São Francisco. The river rises in the state of Minas Gerais. It flows north-east, then eastward, to form the boundary between the states of Bahia and Pernambuco. Then the river turns to the southeast, and empties into the Atlantic Ocean, 3,199 kilometres from its source. As it leaves the mountains in Minas Gerais, it plunges over falls and rapids. Then it is a broad, navigable stream for 1,400 kilometres of its middle course. But 320 kilometres from the Atlantic, the river again becomes swift and rocky.



Alberto Santos-Dumont, left, experimented with powered dirigibles and built the first successful French aeroplane.

São Miguel Island is the largest island of the Azores. It covers 661 square kilometres and has a population of about 131,000. Ponta Delgada is the chief city. The island produces cereals, fruits, potatoes, tea, tobacco, and wine.

São Paulo (pop. 7,033,529; met. area pop. 12,588,439) is Brazil's largest city and leading commercial and industrial centre. It is also the largest city of South America. São Paulo, the capital of the state of São Paulo, lies in southeastern Brazil, about 386 kilometres from Rio de Janeiro. For location, see **Brazil** (political map).

In 1554, Jesuit missionaries from Portugal founded São Paulo as an Indian mission. It remained a small town until the mid-1800s, when it became the commercial centre of Brazil's booming coffee industry. Thousands of Asians and Europeans went to São Paulo State to work on the coffee plantations, and many later moved to São Paulo City. In time, the plantation owners invested much of their profits in industries in São Paulo.

Today, the city and its surrounding area account for about half of Brazil's total industrial output. In the 1970s, São Paulo ranked as one of the fastest-growing major cities in the world in terms of population. By 1980, the São Paulo metropolitan area had become the second largest metropolitan area in the world, after Mexico City.

The city lies on a high plateau about 48 kilometres from the Atlantic Ocean. A steep slope separates São Paulo from the coastal city of Santos, to the southeast. Santos serves as São Paulo's port (see **Santos**). São Paulo covers 1,493 square kilometres, and its metropolitan area occupies 7,951 square kilometres. The Tietê and Pinheiros rivers flow through the city.

Wide avenues and unusually designed skyscrapers give the city a modern appearance. Few of São Paulo's

buildings are even 100 years old, though a chapel built in 1554 and a few old churches still stand. The centre of the city's business district is called the Triangle. This name dates back to the 1500s, when three mission buildings that stood in the area were connected by paths that formed a triangle.

Many hotels and restaurants are northwest of the Triangle. A public square called the Plaza of the Republic features an arts and crafts market each Sunday in this area. Mansions once lined Paulista Avenue, southwest of the Triangle, but most have been replaced by skyscrapers. Flats and offices also have taken the place of houses in other areas. Many residents have moved to the suburbs.

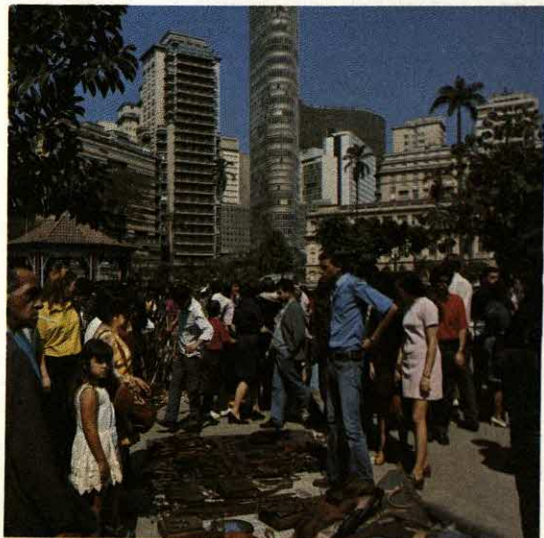
São Paulo has a number of parks, the largest of which is the beautifully landscaped Ibirapuera Park. A monument to the *bandeirantes* (pioneers) of São Paulo stands at the entrance to the park. The nearby Santo Amaro lake region is a popular recreation area. Sports events are held at Morumbi and Pacaembu stadiums.

São Paulo faces many problems associated with a rapid population growth. For example, many homes have neither running water nor sewerage service. Other problems include air pollution, overcrowding, and traffic congestion. In an attempt to solve some of its problems, the city started several water and sewerage improvement projects during the early 1970s. Construction of commercial and recreational facilities outside the central part of the city helped relieve the overcrowding. A rapid transit system opened in 1974.

People of São Paulo are called *Paulistas*. Most of them have ancestors who emigrated from Germany, Italy, Japan, Lebanon, Portugal, Spain, or Syria. Some Paulistas have African or American Indian ancestry.



São Paulo, Brazil, is the largest city in South America and one of the fastest growing cities in the world. Modern buildings crowd the busy centre of São Paulo, *left*. Such spacious recreation areas as Ibirapuera Park, *above*, offer a striking contrast to the noise and congestion of the city centre.



São Paulo's Plaza of the Republic is the site of a weekly arts and crafts market. Shoppers browse through displays of leather goods and other items that are offered for sale.

Since the 1930's, emigration from other countries to São Paulo has decreased. At the same time, migration from other areas of Brazil to São Paulo has increased. About 350,000 Brazilians move to São Paulo annually. These people come to the city largely because it has more jobs and higher wages than other areas of Brazil.

Paulistas speak a variety of languages, but most of them also speak Portuguese, Brazil's official language. Most of the people are Roman Catholics, but many Paulistas belong to local religious groups as well. Some of these groups worship African gods.

Paulistas have the reputation of being the most energetic, hard-working people in Brazil. But they also like to relax. After a morning at their job, many people eat a leisurely lunch and then rest until late afternoon before returning to work. Paulistas enjoy sports, especially soccer. They celebrate the founding of São Paulo on January 25 and All Saints' Day on November 1, in addition to national holidays.

Poverty is a serious problem in São Paulo despite the city's prosperity. More than half the families have a monthly income of less than 150 U.S. dollars. Many of these families live in slum areas called *cortiços*, which consist of many shacks jammed together. The large-scale migration to the city intensifies the problem of poverty. Most of the people who move to São Paulo lack job skills, and many cannot find employment there. The city has made some progress in providing job training and adequate low-cost housing for these people.

Education and cultural life. The University of São Paulo, which has about 44,000 students, is the largest university in Brazil. The city also is the home of Holy Catholic and Mackenzie universities. In addition, São Paulo has a college of medicine, a college of political science, and several fine-arts schools.

São Paulo's Municipal Library ranks as one of the largest public libraries in South America. The city also has a fine system of children's libraries. São Paulo's museums

include institutions of art, folklore, forestry, history, Indian culture, and zoology. A scientific centre, the Butantan Institute, became known for its development of snakebite serums.

São Paulo has sponsored an international art show, the *Bienal*, every other year since 1951. The city's theatres present ballet, opera, orchestral concerts, and plays.

Economy. About 40 per cent of São Paulo's workers have a job in construction or manufacturing. The city produces more than half of Brazil's chemicals, pharmaceuticals, and textiles, plus more than 75 per cent of the country's electrical equipment, machinery, and rubber goods. São Paulo ranks as the leading Brazilian producer of motor vehicles. Other important products include cement, clothing, footwear, furniture, plastics, and processed foods. Nearby rivers provide São Paulo's industries with hydroelectric power.

Roads and railways link São Paulo to agricultural areas and to other Brazilian cities. Two international airports serve the city.

History. Jesuit missionaries from Portugal founded São Paulo as an Indian mission in 1554. As a result of attacks by hostile Indians, the Jesuits joined with some nearby Portuguese colonists and formed one community. The people of São Paulo were poor during this early period. Many of them organized groups to travel to the interior of South America in search of wealth. Members of these groups were called *bandeirantes*.

Until the mid-1600's, the *bandeirantes* sought mostly Indians, whom they captured and sold as slaves to other settlers. The *bandeirantes* later prospected for gold and precious gems. In 1698, *bandeirantes* discovered gold northeast of São Paulo. But the gold rush that followed this discovery produced little wealth.

Cattle trading and sugar planting brought wealth to some Paulistas. By 1800, São Paulo was an administrative and commercial centre with more than 20,000 people. In 1822, Prince Regent Pedro of Portugal declared Brazil's independence while visiting São Paulo.

Coffee planting spread to the area near São Paulo during the mid-1800's. São Paulo soon became the commercial centre of Brazil's coffee industry. The state government encouraged immigration, and foreigners poured into the area. São Paulo's industrial growth began in the late 1800's, when coffee profits were invested in new industries in the city. São Paulo became the capital of São Paulo State in 1891. The city's population increased from about 25,000 in the 1870's to about 240,000 in 1900.

Throughout the 1900's, São Paulo has played an important part in Brazilian politics. In 1932, the city was the base of an unsuccessful revolt against President Getúlio Vargas. From 1968 to 1970, student protests and acts of guerrilla rebellion against the nation's military rule took place in São Paulo.

São Paulo's population has grown rapidly during the 1900's. In the early 1980's, the city had over 7 million people. The rapid growth has worsened the city's problems. During the 1970's, the city, state, and federal governments began to take action to control São Paulo's growth. As a first step, the governments encouraged industrial development in areas other than São Paulo.

See also **Brazil** (pictures); **Latin America** (picture: Sprawling slums).

São Tomé (pop. 34,997) is the capital and largest city of São Tomé and Príncipe, an island country west of the African mainland. The city lies on the northeast coast of São Tomé Island. For location, see **São Tomé and Príncipe** (map).

The city of São Tomé serves as a trading and shipping centre for farm products of São Tomé and Príncipe. The country's only airport is near the capital. The Portuguese discovered São Tomé Island in 1470 and founded the city about 1500.

São Tomé and Príncipe is an African country that consists of two main islands and several tiny islands. The two main islands—São Tomé Island and Príncipe Island—give the country its name. The islands lie in the Gulf of Guinea, about 290 kilometres west of Libreville, Gabon, on the African mainland.

São Tomé and Príncipe has a total land area of 964 square kilometres. São Tomé Island is much larger than Príncipe Island. It accounts for about 85 per cent of the country's area and has almost 95 per cent of its people. About three-fifths of the people of São Tomé and Príncipe live in rural areas and work on farms. The city of São Tomé, on São Tomé Island, is the nation's capital and largest city. The city serves as a trading and shipping centre for the country's farm products.

São Tomé and Príncipe became an independent nation in 1975. It had been ruled by Portugal for most of the period since the late 1400's. In the 1500's, São Tomé Island became a centre for the African slave trade.

Government. São Tomé and Príncipe is a republic. The people elect a national assembly, and the assembly chooses a president. The president appoints a prime minister and a Cabinet to help run the government.

People. For São Tomé and Príncipe's total population, see the *Facts in brief* table with this article. About 70 per cent of the people of São Tomé and Príncipe have a mixed black African and European ancestry. Sometimes called Creoles, they are considered the native people of the islands. People from the African island country of Cape Verde and from the African mainland form the second largest group. Europeans account for a small percentage of the population.

Many of the Creoles own small farms or businesses, or work on fishing crews or as labourers. Some of the Europeans own farms, and others have jobs requiring technical or management skills. Most of the Africans

from Cape Verde and the mainland are labourers with low-paid jobs.

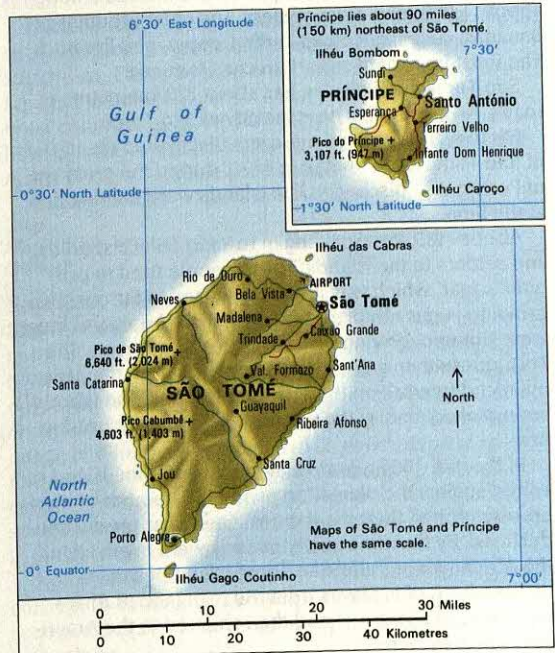
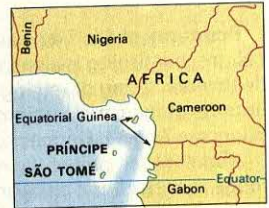
Portuguese is the most widely used language in São Tomé and Príncipe. Many Creoles and Europeans speak a dialect based on Portuguese as it was spoken hundreds of years ago. Roman Catholicism is the main religion among the Creoles and Europeans. Africans from Cape Verde and the mainland use the language and practise the religion of their place of origin. By law, children in São Tomé and Príncipe are required to complete primary school, but many do not do so. Relatively few children go on to secondary school.

Land and climate. The islands of São Tomé and Príncipe are part of a series of extinct volcanoes. The western part of São Tomé Island rises sharply from the sea, and forests grow near the shore. Inland, formations of basalt rock rise steeply toward the centre of the island. The land gradually slopes downward from the centre to the east coast. There, volcanic ash has formed deep deposits of fertile soil. Príncipe Island has a similar land pattern.

São Tomé and Príncipe islands lie a little north of the equator. The country has hot, humid weather from September to May; and hot, dry weather from June to August. The average annual temperature varies from 25 °C in the lowlands to about 18 °C in the highlands. The annual rainfall averages 41 centimetres.

São Tomé and Príncipe

- ⊙ National capital
- Settlement
- + Elevation above sea level
- Road
- Railway



Facts in brief about São Tomé and Príncipe

Capital: São Tomé (city).

Total land area: 964 km². **Coastline**—208 km.

Elevation: *Highest*—Pico de São Tomé, 2,024 m. *Lowest*—sea level.

Population: *Estimated 1996 population*—136,000; density, 137 people per km²; distribution, 62 per cent rural, 38 per cent urban. *1981 census*—96,611. *Estimated 2001 population*—149,000.

Chief products: Bananas, cocoa, coconuts, coffee, copra, livestock.

Flag: The flag has green horizontal stripes (for forests and the sea) at the top and bottom; a yellow horizontal stripe (for soil) in the centre; and a red triangle (for the struggle for freedom) near the staff. Two black stars symbolizing the country's two main islands appear on the yellow stripe. Adopted in 1975. See **Flag** (picture: Flags of Africa).

Money: *Currency unit*—dobra. One dobra = 100 centimos.



On São Tomé and Príncipe, the buildings reflect the architectural style of the Portuguese, who originally colonized the islands. The southern European style of heavy, red roof tiles and thick walls is well suited to the equatorial climate.

Economy of São Tomé and Príncipe is based on agriculture, but fishing is also important. The country has little manufacturing or mining. It is heavily dependent on imports of industrial equipment and food. Its main suppliers are Angola, Germany, Portugal, and Spain.

About 90 per cent of the nation's cultivated land belongs to agricultural companies that operate large commercial farms. The other 10 per cent is divided among about 11,000 small farm owners. The chief products are bananas, cocoa, coconuts, coffee, copra, and livestock. The most important export product is cocoa.

São Tomé and Príncipe has about 290 kilometres of roads. An airport lies near the city of São Tomé.

History. Portuguese explorers discovered the islands of São Tomé and Príncipe in 1470, during the great age of Portuguese discovery. The islands were uninhabited at the time.

About 1485, Portugal began to send convicts, exiles, and settlers to the islands. These people tried to produce sugar, which was in great demand in Europe. But growing sugar requires great physical labour, and there were not enough people to produce large crops. The Portuguese then started to bring slaves from the African mainland to work on the sugar plantations. The islands soon ranked among the world's leading sugar producers.

In the mid-1500's, many slaves on São Tomé Island revolted against the plantation owners. A number of owners abandoned their plantations, and sugar production declined. By that time, many nations were involved in the African slave trade. São Tomé Island became a major centre of it. Slaves from the mainland of Africa were sent to São Tomé and then shipped to the Americas and elsewhere.

The Dutch and the French ruled São Tomé Island during periods of the 1600's and 1700's, but the Portuguese regained control. In the 1800's, Portuguese planters began to grow coffee and cocoa on the islands. They used slave labour to help grow these crops.

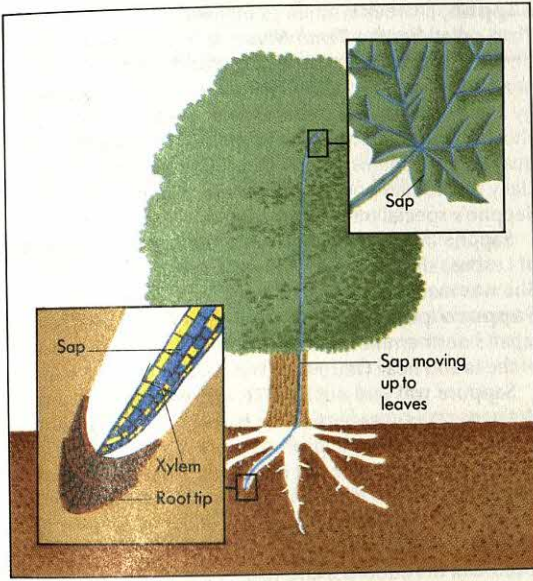
Portugal and most other nations ended slavery in the 1800's. But the Portuguese continued to bring mainland Africans to São Tomé and Príncipe as contract labourers. These workers were treated harshly, and they revolted unsuccessfully from time to time during the 1800's and 1900's. In 1953, Portuguese troops killed hundreds of workers during a protest. This event is called the Batepa massacre.

In the mid-1900's, many people in São Tomé and Príncipe began demanding an end to Portuguese rule. The islands gained independence on July 12, 1975. Since then, the country's leaders have maintained strong relations with Portugal. São Tomé and Príncipe has received loans from Portugal for airport and road construction.

See also **São Tomé.**

Saône River is a waterway in eastern France. It rises near the foothills of the Vosges Mountains and flows for 431 kilometres. The Saône, the most important tributary of the Rhône River, joins it at Lyon. Light ships can sail on it for 373 kilometres. The industrial city, Chalon-sur-Saône, lies on its banks. Canals connect the Saône River to the Moselle, Marne, Yonne, and Loire rivers. For location, see **France** (terrain map).

The Saône flows through the historic region of Burgundy, and the rich agricultural lands of the valley contributed to the region's prosperity. On the hillsides of the Saône's right bank are some of the greatest vineyards of France, including those of the Côte d'Or, Mâcon, and Beaujolais.



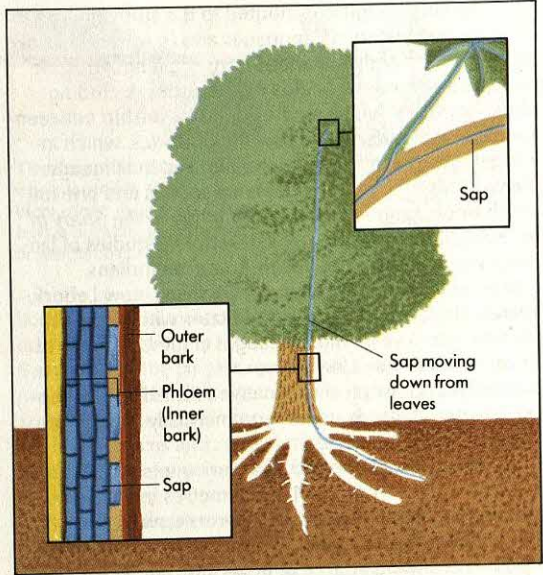
One kind of sap travels from the roots of a tree to the leaves. This sap consists of water and dissolved minerals. It forms near the growing tip of the root, where water and minerals enter the plant. The sap moves up the trunk through a layer of plant tissue called the *xylem* and finally reaches the leaves.

Sap, in botany, means the liquid in the stems and roots of plants. There are really two kinds of sap. One kind of sap is water, with dissolved minerals, that travels from the roots of the tree to the leaves. It moves through a layer in the stem and trunk called the *xylem*. The other kind of sap is water carrying dissolved plant foods. It moves from the leaves to parts of the plant where it is to be used or stored. This kind of sap moves in a layer called the *phloem*.

How sap moves. The xylem sap movement begins near the growing tip of the root, where water and minerals enter the plant. From the region of the root hairs, the water with the minerals dissolved in it moves toward the inside of the root by diffusion. When it reaches the xylem layer in the root, it moves up the root into the xylem of the stem. Finally it passes to the leaves. The force that causes the sap to rise is, to a great extent, a pull from above. The pull results from the *transpiration* (evaporation) of the water from the leaves.

In young trees, the water moves through the xylem in all parts of the wood. But in old trees, the only part of the xylem that transports sap is the part near the bark. This part of the wood is called *sapwood*. The part through which the sap does not move is called the *heartwood*. It is usually possible to tell these two kinds of wood from each other by their colour. Most sapwood is light in colour. Heartwood is usually much darker.

The leaves are the organs of the plant which manufacture carbohydrates from carbon dioxide and water. The plant then uses the carbohydrates as food. Carbohydrates dissolve in water, and form the other kind of sap. In the stems and trunk of the plant, this stream of sap moves downward. The force which causes the downward movement of phloem sap is probably the high os-



Another kind of sap, which is made up of water and dissolved plant foods, travels downward from the leaves of a tree. This kind of sap moves through a layer of plant tissue in the trunk called the *phloem*. This sap collects in parts of the tree where it is to be used or stored.

motric pressure. This pressure results from the movement of water into the sugar-rich cells of the leaves. The pressure passes to the conducting cells of the phloem, and a column of sap is forced downward. At certain times of the year, in some trees, the stream moving upward may also contain carbohydrates. An example is the North American sugar maple, whose rising sap contains sugar.

Uses of sap. The sap of many plants is valuable. Most sugar sold for domestic use is made from the sap of sugar cane. Plants contain other liquids that are not true saps in the botanical sense. Many milky juices have great commercial value. The milky juice of rubber trees becomes the raw material for natural rubber. Gums and resins also are valuable plant juices.

Related articles in *World Book* include:

Gum	Resin
Maple syrup (Production)	Rubber (Natural rubber)
Osmosis	Turpentine

Sapajou. See Capuchin.

Sapir, Edward (1884-1939), was an American anthropologist and linguist who explored the relationships between language, culture, and personality. In anthropology, Sapir helped found two new branches of study: (1) *linguistic anthropology*, which analyses the role of language in different societies, and (2) *psychological anthropology*, which examines the relationship between culture and personality. He also formulated methods by which scholars can reconstruct the history of a culture in the absence of written evidence.

Sapir greatly influenced the modern anthropological concept of culture. This concept emphasizes patterns of acquired traits and the relationship between personality and culture.

In linguistics, Sapir contributed to the study of the structure and history of languages and to the analysis of the differences and similarities between languages. He pioneered several new fields of linguistics, including *ethnolinguistics*, which studies the relationship between language and culture, and *psycholinguistics*, which investigates the mental processes involved in language. The writings of Sapir include many articles and one full-length book, *Language: An Introduction to the Study of Speech* (1921). Most of Sapir's descriptive studies of languages and cultures dealt with American Indians.

Sapir was born in Lauenburg, Germany (now Leborg, Poland). He moved to the United States with his family when he was 5 years old. He taught at the University of Chicago and at Yale University.

Sapodilla is a tropical fruit native to Mexico and Central America. It also is grown commercially in parts of Asia and North America.

Sapodillas may be round, oval, or cone-shaped. The ripe fruit ranges from 5 to 10 centimetres in diameter. It has rough, greyish-brown skin. The soft, sweet flesh is yellowish-brown and filled with large black seeds. The sapodilla is a good source of potassium and vitamin C.

The fruit grows on an evergreen tree that can reach a height of more than 20 metres. The trees are grown from seeds or by *grafting* (see *Grafting*). Grafted trees produce fruit after four or five years, but trees grown from seed take several years longer. Sapodilla trees contain a milky juice called *latex* beneath their bark. The latex is boiled to make *chicle*, an important ingredient in chewing gum (see *Chicle*).

Scientific classification. The sapodilla belongs to the sapodilla family, Sapotaceae. It is *Manilkara zapota*.

Saponin. See *Soapberry*.

Sapphire, a hard and clear gem, is a variety of the mineral corundum. The best-known sapphires are blue. Their colour results from small amounts of iron and titanium in the stone. Sapphires are also found in many other colours, including yellow, green, white, black, violet, and orange. Nonblue sapphires are called fancy sapphires. The red variety of corundum is known as a ruby.

The most valuable sapphires once came from Kashmir, in India. They are a magnificent cornflower blue. Today, Thailand is the most important source of blue sapphires. Blue and fancy sapphires are also found in Burma, Sri Lanka, Australia, and the state of Montana in the United States.

Star sapphires contain needles of the mineral rutile that reflect light in six starlike rays. The most highly prized star sapphires are blue. Black or white star sapphires are less valuable. One of the largest blue star sapphires, the *Star of India*, weighs 563 carats, or about 110 grams. It is on exhibit in the American Museum of Natural History in New York City.

Among minerals, sapphires and rubies rank second only to diamonds in hardness. For this reason, sapphires are sometimes used as abrasive or polishing agents. Large numbers of inexpensive imitation sapphires are manufactured every year. But the natural stones have maintained their high value because of a demand for the real gems. *Gemologists* (gem experts) can distinguish between imitation and natural sapphires. The sapphire is the birthstone for September.

See also *Corundum*; *Gem* (picture); *Ruby*.

Sappho, a Greek woman poet, lived about 600 B.C. Plato called her the *Tenth Muse*, and she is supposed to be the greatest woman poet the world has known. Of her poetry, only two short lyrics and odd lines quoted by ancient critics and grammarians have survived. These show intense but controlled emotion expressed in language which seems wholly natural. Later poets, especially the Roman poets Catullus and Horace, imitated Sappho's special metre, the Sapphic.

Sappho lived at Mitylene (now Mitilini) on the island of Lesbos, and led a circle of young women disciples. She was married, and had a daughter named Cleis.

Sapporo (pop. 1,542,979) is the capital of Hokkaido, Japan's northernmost island. It lies on the western part of the island near Otaru Bay (see *Japan* [political map]).

Sapporo was laid out in 1871, and was patterned after Western cities. It serves as the island's manufacturing and cultural centre. Its products include hemp cloth and rubber goods, condensed milk, and processed soybeans. Sapporo's chief attractions include Hokkaido University and the botanical gardens, which specialize in alpine flora. Residents and visitors enjoy the ski slopes, located in the suburbs, and Jozankei hot springs, 18 kilometres southwest of the city. In 1972, the Winter Olympic Games were held at Sapporo.

Saprophyte is a living thing that gets its food from the remains of dead organisms. Most saprophytes are either fungi—such as mushrooms and moulds—or bacteria. These organisms lack chlorophyll, the green pigment that enables plants to make their own food by *photosynthesis* (see *Photosynthesis*). Saprophytes digest dead tissue for the energy they need to grow and reproduce. This process commonly involves using up carbohydrates to produce carbon dioxide and water. Saprophytes also may digest proteins, fats, or other substances made by living things and break them down into simpler compounds.

The simple compounds produced by saprophytes can be taken up and reused by other organisms. Thus, saprophytes play an important part in the nutrient and energy cycles of living things.

See also *Fungi*; *Mushroom* (How a mushroom obtains food).

Sapsucker is one of a group of birds of the woodpecker family. It lives only in North America. Sapsuckers are so called because part of their diet includes sap from trees. They get this sap by making small holes called *wells* in the bark. They also feed on insects attracted to the sap and on ants and wild fruit. The common sapsucker in the Eastern United States is the *yellow-bellied sapsucker*. The male has a bright scarlet crown and throat, and black upper parts with white markings. In the winter, the sapsucker flies as far south as Central America. It nests in



Sapsucker

holes in trees. The female lays three to seven pure white eggs. The western *red-breasted sapsucker* lives on the Pacific Coast. The adults of both sexes have a red crown, throat, and breast. Sapsuckers have much the same habits as woodpeckers but sometimes injure trees.

Scientific classification. Sapsuckers are members of the woodpecker family, Picidae. The yellow-bellied sapsucker is *Sphyrapicus varius*; and the red-breasted is *S. ruber*.

See also Bird (picture: How birds feed).

Sapwood. See Sap; Tree (How trunks and branches grow thicker; picture: How a tree reveals its history).

Saracens were Muslims who invaded and occupied parts of the Christian world in Asia, Africa, and Europe from the 600's to the 1000's. The Saracens included the people of Palestine and Syria, the Arab Moors who set up the Spanish kingdom in the 700's, and the Seljuks who fought the Crusaders. The Greeks and Romans first used the term *Saracen* to describe the wandering Arab tribes of the Syro-Arabian Desert.

Saragat, Giuseppe (1898-1988), served as president of Italy from 1964 to 1971. Saragat joined the Socialist Party in 1922, and was a member of its executive committee by 1925. He represented the party in the cabinet formed in 1944. In 1946, he was named president of the Constituent Assembly that wrote a new constitution. Saragat left the Socialist Party in 1947 and formed his own party, which later became the Democratic Socialist Party. Saragat was born and educated in Turin.

Saragossa, also spelled *Zaragoza* (pop. 596,080), is an industrial and trading centre in northeastern Spain. The city has metalworks, sugar refineries, chemical plants, and factories that manufacture electrical equipment, agricultural machinery, and furniture. For the location of Saragossa, see Spain (political map).

The central part of Saragossa is a district of ancient, crowded lanes and dilapidated houses. An attractive newer section has grown up around the old quarter.

The city's name comes from *Caesarea Augusta*, which was the name Emperor Augustus gave to the settlement in 25 B.C. Saragossa was the capital of the old kingdom of Aragon from the 1100's to the 1400's.

Sarah. See Ishmael; Isaac.

Sarajevo (pop. 447,687) is the capital of Bosnia-Herzegovina (see *Bosnia-Herzegovina* [map]). Sarajevo is famous for the products of its carpet weavers and silversmiths, and for its many *mosques* (Muslim houses of worship). Turks—who ruled the city from the mid-1400's to 1878—built the mosques. Sarajevo is also famous as the site of the assassination of Austrian Archduke Francis Ferdinand on June 28, 1914. This event started World War I (see *World War I* [introduction]).

From 1946 to 1992, Bosnia-Herzegovina was part of the federal state of Yugoslavia. In 1992, it declared independence. Most of the country's ethnic Muslims and Croats supported independence, but most ethnic Serbs did not. After independence was declared, the Serbs, backed by the Yugoslav National Army, began a war against non-Serbs. Serbian forces set up artillery in the hills overlooking Sarajevo and bombed parts of the city. Thousands of people were killed, and many buildings were damaged or destroyed. A cease-fire went into effect in early 1994.

Saratov (pop. 909,000) is one of the chief ports on the Volga River. For the location of Saratov, see Russia (po-



The flag of Sarawak, above, was adopted in 1988. The emblem, right, displays the state bird, a hornbill, and the state flower, hibiscus.



litical map). Saratov stands about 724 kilometres south-east of Moscow.

Sarawak is the largest state in Malaysia. It lies on the north coast of the island of Borneo. The coastal plains are swampy, and the interior is mountainous. Most people live in towns and rural settlements near the rivers. Sarawak's chief products are oil and natural gas from offshore fields.

People and government. More than 30 per cent of the population in Sarawak are Ibans, 29 per cent are Chinese, and 19 per cent are Malays. Other groups include the Bidayuh and the Melanau. The Ibans are mostly *animists* (worshippers of ancestors and spirits). They live mainly in the lowland forest areas. The Chinese live in the major towns. Most of them are Buddhists. Islam is the religion of the Malays.

The head of state of Sarawak is the *yang di-pertua negeri* (governor). The government also consists of a state cabinet, and a state legislative assembly. The state cabinet is made up of the chief minister, assisted by two deputies, and 15 other ministers and assistant ministers. The state legislative assembly has 56 elected members. There are nine state divisions, sub-divided into 29 districts. See also *Malaysia, Government of*.

Economy. Sarawak underwent rapid economic growth during the 1960's, 1970's, and 1980's.

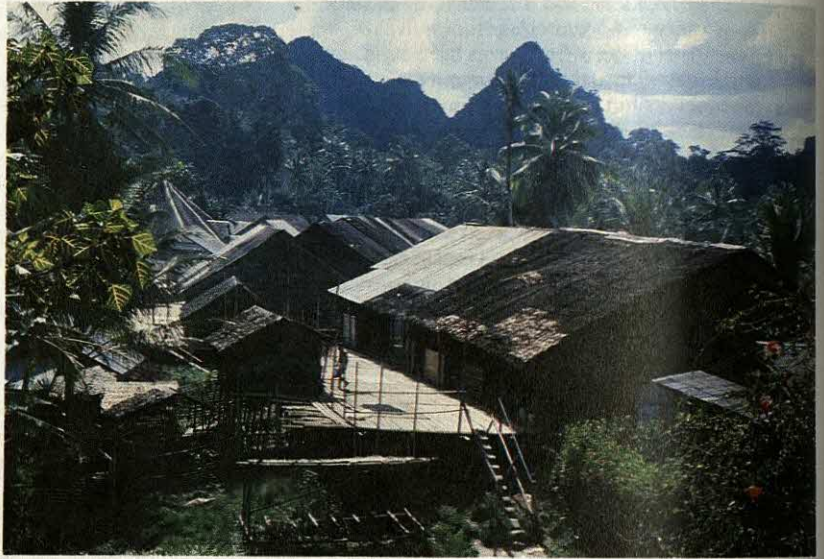
Forestry and agriculture are two of the most important sections of the economy. Timber and forest products account for more than a fifth of Sarawak's total exports. The state has nearly 10 million hectares of forests, capable of yielding 10 million cubic metres of logs annually.

Sarawak is the chief pepper-producing state in Malaysia. The state is rich in agricultural land and there are



Sarawak is a state on the north coast of the island of Borneo. It is the largest state in Malaysia.

A **longhouse** in Sarawak provides accommodation for a whole clan or extended family, and in some cases for a whole village. Longhouses are often raised, riverside dwellings with large verandahs.



many farmers with small plots producing crops for sale, or farming at subsistence level (see **Agriculture** [Subsistence agriculture]). Nearly 3 million hectares are suitable for cultivation but only a fifth of this land is in use. The government is encouraging the large-scale production of cocoa and oil palm.

Sarawak has seven industrial estates in the main towns of Kuching, Sibul, Bintulu, and Miri. Bintulu is the

centre of heavy industries, particularly the export of oil and gas resources. Originally a small fishing village, Bintulu has developed into a modern town with an estimated population of 60,000. Industries include a liquefied natural gas plant, an oil terminal, and a urea-ammonia plant that produces fertilizer.

The economy depends heavily on forestry, petroleum, and natural gas, which account for almost half of the state's gross domestic product. Sarawak is rich in natural gas, most of which is in the Laconia field, off Bintulu. Oil was first discovered in the state in 1910. Production is about one-third of Malaysia's total output. The Malaysian Liquefied Natural Gas Scheme is the single largest industrial project in the country.

Tourists from abroad and other parts of Malaysia also contribute to Sarawak's economy. Visitors take an interest in the state's variety of peoples and their different languages and life styles. There are several national parks with unspoilt jungle and scenic views, which offer the attractions of unusual animals, birds, flowers, and insects. Some of them have extensive cave systems and sites of ancient settlements.

Land. Sarawak is almost the same size as Peninsular Malaysia, stretching over 700 kilometres along the northern coast of Borneo Island. The boundary with Kalimantan runs along the watershed of the Sarawak, Rajang, and Baram rivers.

The state consists of three distinct landforms: the coastal plain, the highland interior, and the foothills between. The alluvial coastal plain consists largely of man-



A **totem pole tomb** at Kuching, Sarawak, reflects ancient religious beliefs concerning the spirits of ancestors.

Facts in brief about Sarawak

Population: 1991 census—1,648,217.

Area: 124,450 km².

Capital: Kuching.

Largest towns: Kuching, Sibul, Bintulu.

Chief products: *Agriculture*—cocoa, oil palm, pepper, rice, rubber, timber. *Mining*—natural gas, petroleum.

Manufacturing—cement, fertilizers, liquified natural gas.

grove and peat swamps up to 150 kilometres wide. The mountainous interior rises from 300 metres to more than 1,200 metres, culminating at Mount Murud (2,425 metres). These areas are heavily forested and inaccessible except by river. Within this zone are spectacular limestone outcrops and their caves. The largest of these caves are in Mount Mulu. The intermediate zone consists of undulating land and foothills, extending throughout the length of the state and the most densely settled area.

The Rajang River (560 kilometres) is the longest in Malaysia. Sibü is its largest port and Kapit, 160 kilometres from the coast, can be reached by coastal craft. The Baram (400 kilometres) is the second longest river and provides access to the Kelabit Highlands and the Mulu National Park in the east.

The equatorial climate is hot and humid. Lowland temperatures range from 25° to 31° C. The average annual rainfall ranges from 330 to 460 centimetres. Humidity is high, and often exceeds 68 per cent. The northeast monsoon from November to February brings heavy rain in the *landas* season. The southwest monsoon from March to September is less wet.

History. Until 1841, the greater part of Sarawak was under the rule of Brunei. As a reward for his success in pacifying a revolt against Brunei, James Brooke became the first raja of Sarawak in 1841, with control of the Sarawak river basin. Brooke, an Englishman, extended his power to Bintulu in 1861. Under the reign of the second raja, Charles Brooke, the area of the state stretched eastward until its frontier reached the Trusan Valley in 1885. Sarawak received British protection in 1888. In 1890, the Limbang Valley became part of the state. Brooke purchased Lawas from the British North Borneo Company in 1905.

Charles Brooke reigned until 1917 when he was succeeded by his son, Charles Vyner Brooke. In 1941, there was a new constitution which marked progress towards self-government. The Japanese occupation of 1942 to 1945 prevented further development. In 1946, Sarawak became a British Crown Colony under the controversial Cession Bill. In 1963, the region joined the new nation of Malaysia.

See also *Malaysia*.

Places to visit

Following are brief descriptions of some of the interesting places to visit in Sarawak:

Gunung Mulu National Park contains a large network of caves and passages which are not yet fully explored. The Clearwater Cave is 51 kilometres long, and the Deer Cave is the largest cave passage known. The Sarawak Chamber is the largest natural chamber in the world. The Mulu Park is also rich in plant and animal life. It contains 1,500 species of flowering plants and many species of mammals, birds, fish, frogs, butterflies, and insects.

Niah Caves are among the most important archaeological sites in Borneo. They are located in the cliffs of Gunung Subis, a limestone hill about 15 kilometres inland from the South China Sea. Tom Harrison, former curator of the Sarawak Museum, discovered traces of Stone Age people in the caves in 1958. Since then, archaeologists have uncovered many stone and bone tools, ornaments, and pottery shards. One of the caves, the Great Cave, shows signs of having been lived in for more than 40,000 years.

Sarcasm. See *Humour* (The types of humour).

Sarcodina. See *Protozoan* (Kinds).

Sarcoidosis is a disease in which small *nodules* (fleshy lumps) form in many parts of the body. Scientists do not know the cause of the disease.

Sarcoidosis can occur in one or more organs, including the bones, eyes, liver, skin, and spleen. In most cases, it occurs in the lymph nodes of the chest and lungs. Lymph nodes are special tissues that help the body fight infection (see *Lymphatic system*). The disease seldom causes death, but it can lead to severe lung damage or other serious complications. Scientists believe sarcoidosis is not contagious.

Symptoms of sarcoidosis may resemble those of cancer or tuberculosis. Sarcoidosis in the lungs may cause coughing, accompanied by fatigue or fever. But some victims of the disease never develop any of these symptoms.

Sarcoidosis can be diagnosed through chest X rays and examination of tissue from one of the lumps. A blood test also can be used to confirm a diagnosis. The disease is common in the United Kingdom, Ireland, Scandinavia, and North America. But it is rare in Japan. It tends to take a more serious form in black Americans. The death rate from sarcoidosis in this group may be up to 10 per cent.

Some sarcoidosis patients have been effectively treated with the drug *cortisone*. Many victims of the disease recover without treatment in a period ranging from a month to two years.

Sarcoma. See *Cancer* (Classification by body tissue).

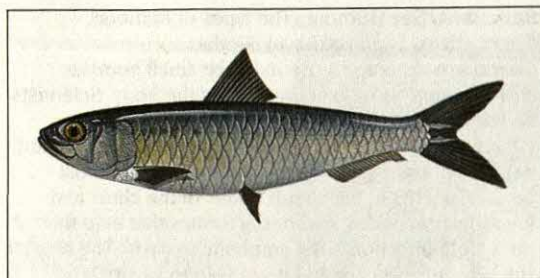
Sarcophagus is a stone coffin. The ancient Egyptians probably first made a sarcophagus for the burial of a king or other important person. The pyramids were built as tombs to house the sarcophagi of the kings of Egypt. Some early Egyptian sarcophagi were shaped like small houses, others as ovals, squares, or oblongs. Later, many were cut in human form and carved with facial features. Many were covered inside and out with inscriptions and figures of gods intended to protect the body from decay. The kings of Phoenicia and Persia were also buried in Sarcophagi. The Greeks often decorated sarcophagi with carved bas-reliefs. The Etruscans made sarcophagi of terracotta. The Romans used marble or stone.

The best-known modern sarcophagi include those of George Washington in Mount Vernon, Virginia, U.S.A., Napoleon Bonaparte in Paris, the Duke of Wellington in London, and the tomb of V. I. Lenin in Red Square in Moscow.

See also *Napoleon I* (picture); *Tomb*; *Sculpture* (picture: The Alexander Sarcophagus).

Sardine is a member of the herring family and an important food fish. The word *sardine* refers to several groups of fishes. But it is used mainly for such species as the *Pacific sardine*, the *South African sardine*, and the *European sardine*, also called the *pilchard*. Other members of the herring family, including sprats and young Atlantic herring, are also sold as sardines. The name *sardine* was given to the fish because they were first caught near the island of Sardinia in the western Mediterranean Sea.

Sardines live in temperate to tropical ocean waters near the shores of almost all the continents. They are es-



A European sardine, or pilchard, grows from 23 to 30 centimetres long. European sardines live in waters off the coasts of western Europe and northern Africa.

pecially plentiful off the coasts of Japan, northwestern Africa, and western South America. Sardines average 23 to 30 centimetres in length and about 113 grams in weight. The upper part of their body is bluish-grey, and the lower part is silvery. Adult sardines live near the surface and usually swim in large shoals. They come to the surface at night to feed on small aquatic organisms called *plankton*.

Sardines *spawn* (lay eggs) mostly in spring. Vast quantities of eggs are laid and left to drift on the ocean surface. Relatively few survive the many ocean predators. Young fish tend to drift into "nurseries" close to the shore.

Most sardine fishing takes place on moonless nights. The movement of sardines disturbs tiny organisms that live near the surface of the sea. It causes these organisms to produce light by means of a chemical reaction. This light, called *bioluminescence*, reveals the presence of sardine shoals. Most sardines are caught with a special type of net called a *purse seine*.

At one time sardine shoals comprised many millions of fish. However, severe over-fishing has caused a steep decline in stocks in some parts of the world. Among the areas worst affected are the coastal waters off California in the United States and southern Africa.

Tins of sardines are a familiar sight on supermarket shelves. Canneries pre-cook sardines and remove part of their natural oil and moisture. Industry uses sardine oil in such products as linoleum, paint, and varnish. Some sardines are made into fish meal, which is used in animal feed and fertilizer. Small sardines are used as bait in commercial tuna fishing.

Scientific classification. Sardines belong to the herring family, Clupeidae. The European sardine is *Sardina pilchardus*. The Pacific sardine is *Sardinops sagax*.

See also Fish (picture: Thousands of sardines); Fishing industry.

Sardinia is an Italian island in the Mediterranean Sea west of the mainland of Italy and over 160 kilometres from it. The nearest land is the French island of Corsica, 14 kilometres north across the Strait of Bonifacio. Sardinia's Italian name is Sardegna. It is second largest of the Mediterranean islands. Only Sicily is larger. Sardinia is about 267 kilometres long from north to south. It has an area of 24,090 square kilometres. This island and some small ones nearby form the region of Sardinia, which has a population of about 1½ million. For the location of Sardinia, see Italy (political map).

Mountainous area. Nine-tenths of Sardinia is mountainous. The only important area of lowlands is the southwestern plain. Human settlement in the mountains is difficult because the steep slopes and heavy rainfall produce landslides and floods. The agricultural improvement of the small areas of level land was retarded in places by swamps and elsewhere by lack of moisture during the hot, dry summers. These problems have been largely overcome by drainage and irrigation.

The most important agricultural products in Sardinia are almonds, grapes, herbs, lemons, olives, oranges, and wheat. Goats and sheep are reared. Tuna and lobster are brought in to local fisheries. Sardinia is also a leading cork producer. Ancient mines still produce copper, iron, lead, lignite, manganese, silver, and zinc.

Sardinia is divided into the provinces of Cagliari, Nuoro, Oristano, and Sassari. The largest cities, in order of population, are Cagliari, Sassari, and Nuoro. Cagliari is the region's capital. The Costa Smeralda (Emerald Coast) in northeastern Sardinia attracts many tourists.

History. Sardinia has been invaded and ruled by first one power and then another. These have included Carthage, Rome, the Vandals, Byzantium, the Muslims, the city-states of Pisa and Genoa, and Aragon. The people of Sardinia preserve many ancient customs, traditions, and costumes.

During World War II (1939-1945), Sardinia became an important aeroplane and naval base for Italy. In 1943, American planes smashed two convoys at Sardinia, and destroyed many airfields. Later attacks damaged more Italian vessels in Sardinia. But the war made little permanent impression on Sardinia.

Since the war, the Italian government and the government of Sardinia have attempted to improve living conditions on the island. Large construction projects have made water and electricity more widely available, and many roads have been improved. Tourism has become an important part of Sardinia's economy. Factories have been built, but unemployment remains a problem.

See also Sardinia, Kingdom of.

Sardinia, Kingdom of, became the nucleus of united Italy. The kingdom was founded in 1720 when the Duchy of Savoy, a territory in northwest Italy, was joined with the island of Sardinia. The kingdom included the Piedmont region, on which the Duchy of Savoy was centred. As a result, the kingdom is also known as Piedmont-Sardinia or simply Piedmont. Victor Amadeus II of Savoy became the first monarch of the Kingdom of Sardinia.

Pinned between French, Austrian, and Spanish powers, the Kingdom of Sardinia nevertheless maintained its independence and expanded its territory during the 1700's. But in 1801, Napoleon Bonaparte annexed the Piedmont region to France, leaving only the island of Sardinia under the king's control. After Napoleon's defeat in 1814, Piedmont was returned to the Kingdom of Sardinia, and Genoa and Liguria were added to the kingdom. As a result, the Kingdom of Sardinia became the foremost independent state of the Italian peninsula.

By the 1830's, many Italians wanted to establish a unified Italian republic. These nationalists placed their hope in Charles Albert, who became monarch of the Kingdom of Sardinia in 1831. He granted his people a constitution in 1848. That same year, the Italian region of

Lombardy revolted against Austrian rule, and Charles Albert sent troops to help drive the Austrians out of Italy. The king suffered a defeat at Novara, and he abdicated in favour of his son, Victor Emmanuel II.

The movement to unify Italy finally succeeded through the efforts of the Kingdom of Sardinia's prime minister, Camillo Benso, the Count di Cavour. Cavour obtained an alliance with France and provoked war with Austria in 1859. In a separate peace with Austria, France obtained Lombardy for the Kingdom of Sardinia. Patriots in several other states in northern and central Italy overthrew their rulers in 1859 and voted for union with the Kingdom of Sardinia in 1860. That year, Giuseppe Garibaldi and his followers brought southern Italy into the nation. In 1861, Victor Emmanuel II became king of a united Italy that included Sardinia.

See also **Cavour, Count di; Italy** (History; map: The unification of Italy); **Sardinia; Victor Emmanuel II**.

Sardis, an ancient city near present-day Izmir, Turkey, was capital of the kingdom of Lydia. The oldest remains of Sardis go back to the 1300's B.C., but there are other indications that the city is older. Persians conquered Sardis in about 545 B.C. The city was later destroyed and rebuilt several times, until its final destruction by the Sassanian Persians about A.D. 615.

Sardonyx is a variety of *chalcedony*, a fine-grained form of the mineral quartz. Most sardonyx has straight or slightly curved bands of reddish-brown and white. The chief sources of sardonyx are Brazil, Uruguay, and India. Sardonyx is one of the less expensive gemstones. It is used in rings and other jewellery. Jewellers usually cut it flat or with a domed shape to bring out the bands of colour. Cameos are sometimes cut from sardonyx to take advantage of its layers of colour. Sardonyx is one of the birthstones for August.

See also **Cameo; Chalcedony; Gem; Onyx**.

Sardou, Victorien (1831-1908), was one of the most successful French playwrights of his time. He was equally skilled at light comedy (*La Scrap of Paper*, 1860), melodrama (*La Tosca*, 1887), and historical drama (*Madame Sans-Gêne*, 1893).

Sardou's works are examples of the *well-made play*, which was carefully constructed on a formula that kept the plot clear and well-paced but lacked any great depth of meaning. Many of Sardou's plays were written for the French actress Sarah Bernhardt. He was born in Paris.

See also **Opera** (*Tosca*).

Sargasso Sea is an irregular oval-shaped area of the North Atlantic Ocean. Its centre is about 3,200 kilometres west of the Canary Islands. It lies roughly between the 20th and 40th parallels of north latitude, and between the 35th and 75th meridians west of Greenwich. No land boundaries mark off this body of water from the rest of the open ocean. It is set apart only by the presence of seaweeds that float on its surface. It is also a region of slow ocean currents surrounded by a boundary of rapidly moving currents, such as the Gulf Stream

and the North Equatorial Current. The Sargasso Sea derives its name from *sargaço*, a Portuguese word for *sea-weed*. Christopher Columbus is given credit for the first reliable report on this region. He took tests in 1492 to make sure that no rocks lay beneath the sea's weeds.

Legends of the sea

The early navigators who sailed their small ships to North America saw the Sargasso Sea as patches of gulfweed that seemed to form wide-spreading meadows. Soon there were legends and myths about the region that told of large islands of thickly matted seaweed inhabited by huge monsters of the deep. Poets and novelists used their imaginations in describing the sea. They pictured a blanket of netted seaweed from which no ship could escape once it became tangled in the weeds. They described many of the ghost ships of the past as huddled together in a weaving, rotting mass. Shapeless hulks of ancient galleons, covered with weeds and barnacles, were pictured lying beneath the waters of this mysterious sea. The passing years contributed skeletons of slave ships, then of pirate ships, and later of the gallant ships of the American Revolution. Wrecks of clipper ships and the latest doomed ships completed the legendary collection.

Facts about the sea

Scientists have changed the picture of the Sargasso Sea. They have shown that its area is about 5.2 million square kilometres, and they have opened up fascinating research problems.

Origin of the seaweed. Scientists believe that the seaweed first came from the shores of the West Indies, after it had been torn loose by wind and wave. Parts of it became adapted to living and growing in the open sea. The weeds developed a method of reproduction that enables them to multiply and grow without producing seeds. Waves break off sections of the mature weeds. These fragments then grow into full-size seaweeds in the same way that a cutting from a grape plant grows into a large grapevine. The weeds are supported by air sacs which resemble tiny grapes, and grow as a part of the weeds. Sargassum weeds grow in many ocean regions. One variety is used as food in Japan.

Many small marine animals have adapted themselves to growing on and among the weeds. These animals include tiny crabs, shrimps, and barnacles. Fish can see at depths as great as 365 metres in the Sargasso Sea, the deepest that fish can see in any ocean. Sargassum fish are difficult to distinguish from Sargassum weeds, because the fish have taken on the colours of the weeds.

The greatest quantity of seaweed is found in the central part of the Sargasso Sea. It occurs in scattered masses, some 30 metres in diameter. Wind action forms long strips of the weed, which follow the general direction of the wind. Patches of the weed may cover more than 0.5 hectare. Nowhere is the region so thickly covered that the weeds can interfere with the movements of a ship. Sometimes, unusually strong winds or currents cause some of the weeds to drift into the Gulf Stream, and eventually to New England in the United States or even Ireland and Norway.

Waters of the sea. The waters of the Sargasso Sea have many distinctive features. The water has an unusu-



The Sargasso Sea

ally deep blue colour; a high salt content (3.7 per cent); a high temperature (up to 28° C); and extreme clearness. These features result chiefly from the location of the sea and its great depth, averaging over 4.5 kilometres. However, because water largely circulates within the sea, oil and solid-waste pollution sometimes collect there.

See also **Eel**; **Seaweed**.

Sargent, John Singer (1856-1925), was an American painter who did his major work in Europe. He lived much of his adult life in England, and today his works hang in the Tate Gallery in London as examples of English painting of the late 1800's.

Sargent established his reputation as a portrait painter, and is best known for his perceptive portraits of fashionable people. Although Sargent might broadly brush in his subjects' clothing or accessories, he captured their personalities with remarkable accuracy.

Sargent was born in Florence, Italy, to American parents. He made the first of many trips to the United States in 1876. He studied in Italy and France and his first major exhibition was at the Paris Salon of 1878. Sargent moved to London in 1884 and made England his permanent home although he never became a British subject. During the last dozen years of his life, he virtually gave up portrait painting to paint other more personally satisfying subjects and murals.

Sargent received many awards and honours during his lifetime, but his reputation declined after his death. However, since the mid-1950's interest has slowly revived in his work.

Sargent, Sir Malcolm (1895-1967), was a leading British conductor. He became particularly famous for conducting the Henry Wood Promenade Concerts. Sargent was chief conductor of the BBC Symphony Orchestra from 1950 to 1957, when he became conductor-in-chief of the Promenade Concerts. He continued in this position until his death.



The Daughters of Edward Darley Boit (1882), an oil painting on canvas; Museum of Fine Arts, Boston, U.S.A.

A painting by John Singer Sargent was one of the artist's earliest elegant and fashionable portraits. Sargent gained international fame for his realistic but flattering portraits.

Sargent was born and educated at Stamford, in Lincolnshire, England. He worked as a church organist for a period. After serving in the army in World War I (1914-1918), Sargent started conducting. He became a professor of the Royal College of Music in 1923. He later conducted many orchestras and visited many countries. In addition to his own compositions, Sargent conducted first performances of works by Ralph Vaughan Williams and Sir William Walton.

Sargon of Akkad was a king who founded the first great empire in history. He built his empire in Mesopotamia (now mostly Iraq) during the 2300's B.C. and gained control over much of southwestern Asia. Sargon was an outstanding military leader and administrator. He was one of the earliest kings to maintain a permanent army and to appoint associates from the royal court to serve as the governors of conquered cities. He organized his empire so well that it survived under his successors for over 60 years.

Sargon started his political career as a high court official under King Ur-Zababa of Kish, one of the city-states of Sumer in southern Mesopotamia (see **Sumer**). Sargon later conquered Kish and the other Sumerian city-states. Then he led his soldiers to a series of victories that extended his empire to what is now Iran in the east and to the Mediterranean Sea and Asia Minor (now Turkey) in the west. In central Mesopotamia, Sargon built a magnificent capital city called Akkad (or Agade). He reigned for 56 years. Sargon was a Semite, a person who speaks a Semitic language, such as Arabic or Hebrew. During his rule, Semites replaced the Sumerians as the most powerful inhabitants of Mesopotamia. These Semites and their language came to be called Akkadian, after Sargon's capital.

Sargon's fame gave rise to many legends about him. One legend describes the infant Sargon as being rescued from a basket floating in a river. There is a similar story about Moses, the great Hebrew leader who lived about 1,000 years later.

Sari. See **India** (Clothing).

Sarich, Ralph (1938-), an Australian inventor, completed the first prototype of his revolutionary orbital engine in 1971. In 1973, Broken Hill Proprietary Company Ltd. (BHP) joined with Sarich to provide backing for the development of the engine. This joint development venture resulted in the formation of Orbital Engine Company.

Sarich's orbital combustion process engine eliminates complex cylinder heads and valve trains and can be produced with existing tooling. This engine later replaced the original orbital engine concept. The engine uses advanced fuelling systems and combustion techniques developed by the company and is estimated to cost 30 per cent less than conventional engines. It demonstrates compactness and weight advantages lacking in conventional engines.

Sarich was born in Baskerville, Western Australia. After leaving school, he qualified as a fitter and turner. During and after his apprenticeship, he studied mechanical engineering. He later set up his own engineering business.

Sark (pop. 604) is one of the Channel Islands, about 110 kilometres south of England and 35 kilometres off the French coast. Sark is only about 4.8 kilometres long and

2.4 kilometres wide. It is the smallest self-governing unit in the United Kingdom. The island is divided into two parts: Little Sark and Great Sark, connected by a narrow strip of land called *La Coupée*. Many bays and coves cut into the coastline. Cliffs rise on all sides of the island. Tractors are the only motor vehicles allowed on Sark. The major forms of transportation are bicycles and horse-drawn carriages. Sark has a mixture of feudal and



Sark is one of the Channel Islands. Its two parts, Great Sark and Little Sark, are joined by *La Coupée*, a narrow strip of land.

democratic government. The Seigneur of Sark is the head of the island. Creux, the main village and landing place, lies on the east. Sark is reached by boat from Jersey, which has air and steamer services from England. German troops occupied the island during World War II (1939-1945).

See also Channel Islands.

Sarmiento, Domingo Faustino. See Latin-American literature (Romanticism).

Sarnoff, David (1891-1971), an American businessman, was one of the first people to see the full possibilities of using radio and television to entertain the public. From 1930 to 1949, he served as president of the Radio Corporation of America (RCA). As chairman of the board from 1947 to 1970, Sarnoff built RCA into a major radio and television manufacturer.

Sarnoff was born in Uzlian, near Minsk, Belarus. He moved to the United States in 1900. In 1906, he taught himself Morse code and was hired by the Marconi Wireless Telegraph Company of America. In 1912, Sarnoff picked up signals about the sinking liner *Titanic*. For 72 consecutive hours, he relayed the names of survivors. American Marconi became part of RCA in 1919, and at Sarnoff's urging, RCA formed the National Broadcasting Company (NBC) in 1926. In the 1930's, Sarnoff worked to develop television broadcasting. He later led efforts to develop colour TV.

Sarong. See Indonesia (Clothing).

Saroyan, William (1908-1981), was an American writer. He became known for plays and stories that praise the common person's ability to live a full, happy

life in a world of ugly reality. In the preface to one of his plays, Saroyan wrote: "In the time of your life, live, so that in that good time there shall be no ugliness or death for yourself or for any life your life touches." Saroyan's works show his belief in people's basic innocence. Most are about poor, down-and-out people whose vitality and purity he praises. Some of his works tend to be sentimental rather than objective, especially his portraits of children and of working-class life.

Saroyan was born in Fresno, California. His first book was a collection of stories, *The Daring Young Man on the Flying Trapeze* (1934). Saroyan won the Pulitzer Prize for *The Time of Your Life* (1939), the best of his several plays, but refused to accept the award. He said he disapproved of literary prizes. His other works include a novel, *The Human Comedy* (1943); several autobiographical works, which include *Not Dying* (1963) and *Chance Meetings* (1978); and a collection of nonfiction pieces, *Obituaries* (1979).

See also American literature (Regionalists).

Sarsfield, Patrick (1645?-1693), Earl of Lucan, was an Irish leader and soldier. He fought on the side of James II of England and Scotland against William III of England, Scotland and Ireland in Ireland. He took part in the Battle of the Boyne, and directed the defence of Limerick. His greatest exploit was the destruction of a siege train of artillery and ammunition being conveyed to Limerick by William's soldiers. The soldiers halted for the night at the village of Ballyneety. Sarsfield and a small group of men surprised them and destroyed the siege train. Sarsfield was born at Lucan, near Dublin. He was created Earl of Lucan by James II. After the Treaty of Limerick, he left Ireland and joined the French army.

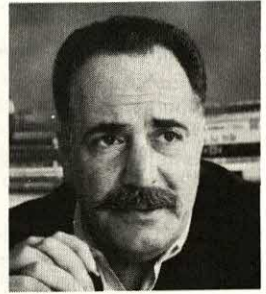
See also Irish Brigade; Wild Geese.

Sarto, Giuseppe. See Pius X, Saint.

Sartre, Jean-Paul (1905-1980), was a French existentialist philosopher who expressed his ideas in many novels, plays, and short stories, as well as in theoretical works.

The bare existence of things, especially his own existence, fascinated and horrified Sartre, because there seems to be no reason anything should exist. In his first novel, *Nausea* (1938), he described the horror and mystery which a man experiences when he considers the unexplainable fact of a thing's existence.

In his chief philosophical work, *Being and Nothingness* (1943), Sartre investigated the nature and forms of



William Saroyan



Patrick Sarsfield

existence or being. He claimed that human existence, which he called "being-for-itself," is radically different from the existence of such inanimate objects as tables, which he called "being-in-itself." Sartre said that only human existence is conscious of itself and of other things. He argued that inanimate objects simply are what they are; however, people are whatever they choose to be.

Sartre said that a person is not a coward, for example, in the same simple way that a table is only a table. A person is a coward only by choice. Sartre said that a person, unlike a table, has no fixed character or "essence" that has been assigned. Primarily, people "exist" as beings who must *choose* their own character or "essence." Thus, in his essay *Existentialism and Humanism* (1946), he defined existentialism as the doctrine that, for humankind, "existence precedes essence." See *Existentialism*.

Sartre believed that people are completely free, but are afraid to recognize this freedom and to accept full responsibility for their behaviour, which such freedom implies. Thus, people tend to deceive themselves about their true situation. Throughout his philosophical and literary works, Sartre examined and analysed the varied and subtle forms of *self-deception*.

Sartre criticized Sigmund Freud's psychoanalytic theory of human behaviour and offered his own "existential psychoanalysis." Sartre said the ultimate motive for all human behaviour is the desire to achieve perfect self-sufficiency by becoming the cause of one's own existence. However, he argued that this goal is self-contradictory and impossible to attain. Therefore, he considered all human activity ultimately futile. As Sartre said: "Man is a useless passion." He identified this idea of perfectly self-sufficient beings who are the cause of their own existence as the traditional idea of God. According to Sartre, each of us wants to become God, and God cannot possibly exist. In the *Critique of Dialectical Reason* (1964), Sartre presented his political and sociological theories, which he considered to be a form of Marxism.

Sartre's plays include *The Flies* (1943), *No Exit* (1944), *Dirty Hands* (1948), and *The Condemned of Altona* (1959). He wrote *The Roads of Freedom*, a sequence of novels including *The Age of Reason* (1945), *The Reprieve* (1945), and *Troubled Sleep* (1949). He applied his psychoanalytic theories in his biographies, *Baudelaire* (1947) and *Saint Genet* (1953). *Words* (1963) is an autobiographical account of his youth.

Sartre was born in Paris where he studied at the École Normale Supérieure. During World War II (1939-1945), he fought in the French Army and was active in the French resistance movement. Sartre founded the monthly review *Les Temps Modernes* in 1945 and served as its editor. In 1964, Sartre was awarded the Nobel Prize for literature. However, he refused to accept the award.



Jean-Paul Sartre

Saskatchewan (pop. 988,928) is one of the Prairie Provinces of Canada. It is the greatest wheat-growing region in North America. Its farmers produce about half of Canada's wheat. The province's vast wheat fields gave it the nickname of *Canada's Breadbasket*. Railways carry huge loads of the grain to Canadian ports for shipment to all parts of the world.

Sassafras is a medium-sized tree of the laurel family. It is found chiefly in the Eastern United States. It also grows as a shrub along roads. The tree grows best in open woods in moist, well-drained soils. It may reach a height of 30 metres.

The sassafras tree bears small, pale-yellow flowers. The leaves have one, two, or three lobes. The two-lobed leaves are shaped like a mitten. The green twigs, leaves, and bark have a spicy taste and fragrance. Sassafras tea is prepared by boiling the root bark. Oil of sassafras is



The sassafras tree has slender branches.

distilled from the roots and bark and used to perfume soap. The soft, yellow wood is used for panelling, furniture, and fence posts.

Scientific classification. The sassafras tree belongs to the laurel family, Lauraceae. It is *Sassafras albidum*.

Sassanid dynasty. See Persia, Ancient (History).

Sassenach means *English* or *Englishman*. The term comes from a Gaelic word meaning *Saxon*. It is used by the Irish, but chiefly by the Scots, when referring to an Englishman. In Scotland, Highlanders use it as a term of abuse for Lowlanders.

Sassoon, Siegfried (1886-1967), a British novelist and poet, used experiences in World War I in *Memoirs of George Sherston* (1937). His works also include *The Old Century* (1938) and the volumes of poetry *Melodies* (1913), *The Old Huntsman* (1917), *Counter-Attack* (1918), *Satirical Poems* (1926), *Vigils* (1935), and *Rhymed Ruminations* (1940).

Siegfried Lorraine Sassoon was born in Kent. He was educated at Cambridge University.

Satan. See Devil.

Satellite, in astronomy, is a body that revolves about a planet. The word *satellite* means *an attendant*. Our moon, which circles the earth in its journey around the sun, is a satellite. The faint or dark bodies that revolve about certain stars and cause their light to dim and brighten are also called satellites. The stars they attend are called eclipsing variable stars. At least seven planets in our solar system have satellites. These planets are Earth, with 1 satellite; Pluto, with 1; Mars, with 2; Neptune, with 2; Uranus, with 15; Jupiter, with 16; and Saturn, with 18. See the separate planet articles, such as **Jupiter**. See also **Moon**.

Satellite, Artificial, is a manufactured object that continuously orbits the earth or some other body in space. Most artificial satellites orbit the earth. People use them to study the universe, help forecast the weather, transfer telephone calls over the oceans, assist in the navigation of ships and aircraft, monitor crops and other resources, and observe movements of military equipment on the ground.

Artificial satellites also have orbited the moon, the sun, Venus, and Mars. Such satellites mainly gather information about the bodies they orbit.

Strictly speaking, manned spacecraft in orbit—space capsules, space shuttle orbiters, and space stations—are artificial satellites. So, too, are orbiting pieces of "space junk," such as burned-out rocket boosters and empty fuel tanks that have not fallen to the earth. This article does not deal with these kinds of satellites. For information on manned spacecraft, see **Space exploration**.

Artificial satellites differ from *natural satellites*, natural objects that orbit a planet. The earth's moon is a natural satellite. See **Satellite**.

The Soviet Union launched the first artificial satellite, Sputnik 1, in 1957. Since then, the United States and many other countries have developed, launched, and operated satellites. Today, more than 2,000 satellites are orbiting the earth.

Satellite orbits

Satellite orbits have a variety of shapes. Some are circular, while others are highly *elliptical* (egg-shaped). Orbits also vary in altitude. Some circular orbits, for example, are just above the atmosphere at an altitude of about 250 kilometres, while others are more than 32,200 kilometres above the earth. The greater the altitude, the longer the *orbital period*—the time it takes a satellite to complete one orbit.

A satellite remains in orbit because of a balance between two factors: (1) the satellite's *velocity* (speed at which it would travel in a straight line), and (2) the gravitational force between the satellite and the earth. Were it not for the pull of gravity, a satellite's velocity would send it flying away from the earth in a straight line. But were it not for velocity, gravity would pull a satellite back to the earth.

To help understand the balance between gravity and velocity, consider what happens when a small weight is attached to a string and swung in a circle. If the string were to break, the weight would fly off in a straight line. However, the string acts like gravity, keeping the weight in its orbit. The weight and string can also show the relationship between a satellite's altitude and its orbital period. A long string is like a high altitude. The weight takes a relatively long time to complete one circle. A short string is like a low altitude. The weight has a relatively short orbital period.

Many types of orbits exist, but most artificial satellites travel in one of three types: (1) *high altitude, geosynchronous*; (2) *sun-synchronous, polar*; and (3) *low altitude*. Most orbits of these three types are circular.

A **high altitude, geosynchronous orbit** lies above the equator at an altitude of about 35,900 kilometres. A satellite in this orbit travels around the earth's axis in exactly the same time, and in the same direction, as the earth rotates about its axis. Thus, as seen from the



An artificial satellite is designed to carry out a specific mission. One major type of satellite, called a communications satellite, performs the task of relaying information between different points in space and on the earth. The Tracking and Data Relay Satellite (TDRS), left, carries out this mission, as evidenced by its many aerials. The umbrella-shaped and dishlike structures are aerials, as are the spike-shaped objects extending from the box in the middle of the satellite.

Important satellites

Date orbited	Name	Accomplishments	Date orbited	Name	Accomplishments
Scientific research satellites			Communications satellites		
1957 Oct. 4	Sputnik 1	First artificial satellite.	1958 Dec. 18	Score	First voice transmission from a satellite.
1957 Nov. 3	Sputnik 2	First satellite with an animal (a dog) aboard.	1960 Aug. 12	Echo 1	First communications satellite to relay messages by reflection.
1958 Jan. 31	Explorer 1	First U.S. satellite; discovered earth's radiation belts. Discovered earth is slightly pear-shaped; first solar-powered satellite.	1960 Oct. 4	Courier 1B	First communications satellite to relay messages electronically.
1958 Mar. 17	Vanguard 1	First satellite in orbit around the sun.	1962 July 10	Telstar 1	Relayed first TV pictures across the Atlantic Ocean.
1959 Jan. 2	Luna 1	Returned first images of earth taken from a satellite.	1963 July 26	Syncom 2	First functional satellite in a geosynchronous orbit.
1959 Aug. 7	Explorer 6	First satellite to return animals (two dogs) from orbit.	1965 Apr. 6	Early Bird	First commercial communications satellite.
1960 Aug. 19	Sputnik 5	Orbiting Solar Observatory, used to study the sun.	1982 Sept. 28	Intelsat 5 F-5	Carries 12,000 voice channels and two television channels simultaneously.
1962 Mar. 7	OSO	First international satellite (American and British). Carried telescopes to study distant stars.	1983 Apr. 5	TDRS	Relays communications between other satellites and earth.
1962 Apr. 26	Ariel 1	Used to survey and search for X-ray sources.	1983 Apr. 11	RCA Satcom 6	First fully transistorized nonmilitary satellite.
1968 Dec. 7	QAO A2	Used to study how atmospheric dust and aerosols affect sunlight.	Navigation satellites		
1977 Aug. 12	HEAO-1	Mapped the magnetic field near the earth.	1960 Apr. 13	Transit 1B	First navigation satellite.
1979 Feb. 18	Sage	Observed the sun during a period of maximum solar activity.	1961 June 29	Transit 4A	First satellite with a nuclear power supply.
1979 Oct. 30	MAGSAT	Performed all-sky survey for sources of infrared radiation in outer space.	1989 Feb. 14	GPS 2-1	First satellite in a network called the Global Positioning System.
1980 Feb. 14	SMM	Mapped remnants of energy released during the early moments of the universe.	Earth observation satellites		
1983 Jan. 25	IRAS	First satellite launched from an aeroplane in flight.	1966 Feb. 3	ESSA 1	First operational environmental survey satellite.
1989 Nov. 18	COBE	Very high-resolution optical telescope; largest in orbit.	1972 July 23	ERTS-1 (Landsat 1)	First satellite to map earth's resources continuously and comprehensively.
1990 Apr. 5	Pegsat	Measures gamma rays originating in outer space and maps their sources.	1976 May 4	LAGEOS-1	Measures movements in the earth's crust.
1990 Apr. 25	HST	First successful weather satellite.	1983 Apr. 17	Rohini 3	Mapped resources for India.
1991 Apr. 7	GRO	First satellite to monitor cloud cover and observe conditions over most of the earth's surface.	1990 Jan. 22	SPOT 2	Maps earth's resources at high resolution.
Weather satellites			Military satellites		
1960 Apr. 1	Tiros 1	Provided high-resolution images of weather conditions.	1959 Feb. 28	Discoverer 1	First satellite in a polar orbit.
1964 Aug. 28	Nimbus 1		1960 May 24	Midast 2	Designed to detect enemy missile launches.
1970 Dec. 11	NOAA-1		1960 Aug. 10	Discoverer 13	First object recovered from orbit.
			1976 Apr. 30	NOSS-1	Monitors locations of ships.
			1987 June 20	DMSP	Provides weather data for military operations.

earth, the satellite always appears at the same place in the sky overhead. To boost a satellite into a high altitude, geosynchronous orbit requires a large, powerful launch vehicle.

A **sun-synchronous, polar orbit** passes almost directly over the North and South poles. A slow drift of the orbit's position is coordinated with the earth's movement around the sun in such a way that the satellite always crosses the equator at the same local time on the earth. Because the satellite flies over all latitudes, its instruments can gather information on almost the entire surface of the earth. One example of this type of orbit is that of the NOAA-H satellite, which monitors the weather. The altitude of the orbit is 870 kilometres, and the orbital period is 102 minutes. When the satellite crosses the equator, the local time is always either 1:40 a.m. or 1:40 p.m.

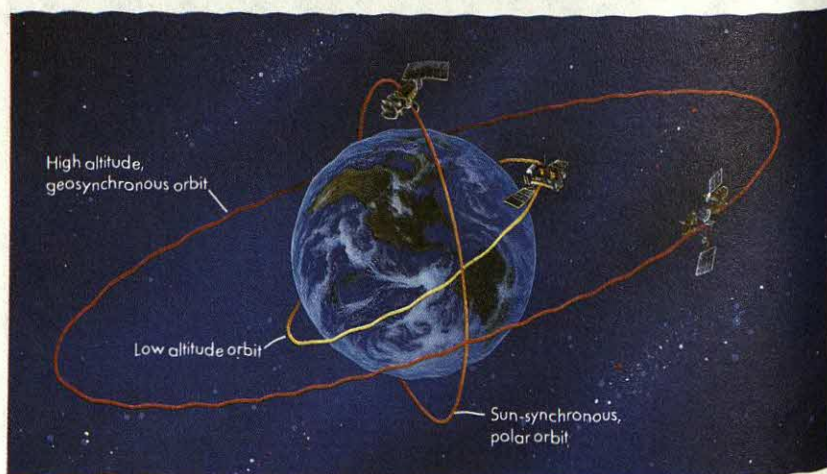
Satellite orbits

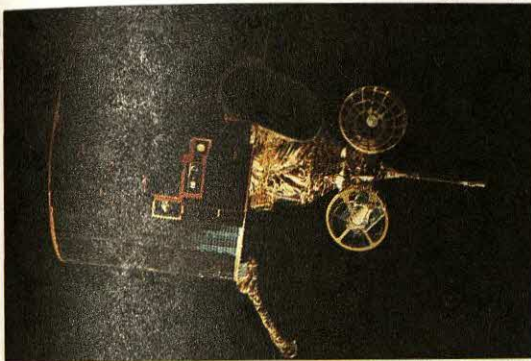
Most artificial satellites travel in one of the three types of orbits shown on the right. A **high altitude, geosynchronous orbit** is above the equator at an altitude of about 35,900 kilometres. A **sun-synchronous, polar orbit** passes almost directly over the North and South poles several hundred kilometres above the earth. A **low altitude orbit** is in an almost airless level of the atmosphere that begins about 480 kilometres above the earth.

A **low altitude orbit** is within the earth's atmosphere, but the highest layer, where there is almost no air to cause drag on the spacecraft and slow it down. Because the orbit is so low, less energy is required to launch a satellite into it than would be needed to place the same satellite into either of the other two main types of orbit. Satellites that point toward deep space and provide scientific information generally operate in this type of orbit. The Hubble Space Telescope, for example, operates at an altitude of about 610 kilometres, with an orbital period of 97 minutes.

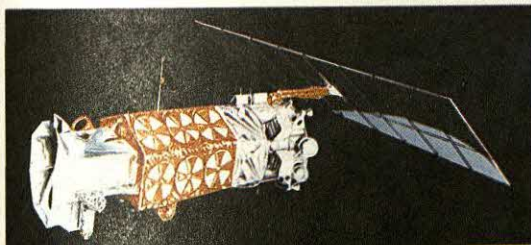
Types of artificial satellites

Artificial satellites are classified according to their mission. There are six main types of artificial satellites: (1) scientific research, (2) weather, (3) communications, (4) navigation, (5) earth observation, and (6) military.





A weather satellite in geosynchronous orbit observes atmospheric conditions over a large area to help scientists study and forecast the weather.



A United States military satellite provides weather information that could be used to advantage in wartime.



A scientific satellite, the Compton Gamma Ray Observatory, detects *gamma rays*, high-energy waves given off by such objects as supernovas and quasars, and by matter near black holes.

Scientific research satellites gather data for scientific analysis. These satellites are usually designed to perform one of three kinds of missions. (1) Some gather information about the composition and effects of the region of space near the earth. These satellites are placed in a variety of orbits. (2) Other satellites record changes in the earth and its atmosphere. Many of these satellites travel in sun-synchronous, polar orbits. (3) Still others observe planets, stars, and other distant objects. Most of these satellites operate in low altitude orbits. Scientific research satellites also orbit other planets, the moon, and the sun. Their instruments collect information and relay it back to earth.

Weather satellites help scientists study weather patterns and forecast the weather. Weather satellites constantly observe the atmospheric conditions over large areas.

Some weather satellites travel in a sun-synchronous, polar orbit, from which they make close, detailed observations of weather over the entire earth. Their instruments measure cloud cover, temperature, air pressure, precipitation, and the chemical composition of the atmosphere. Because these satellites always observe the earth at the same local time of day, scientists can easily compare weather data collected under constant sunlight conditions.

The network of weather satellites in these orbits also function as a search and rescue system. They are equipped to detect distress signals from all commercial, and many private, planes and ships.

Other weather satellites are placed in high altitude, geosynchronous orbits. From these orbits, they can always observe weather activity over nearly half the surface of the earth at the same time. These satellites photograph changing cloud formations. They also produce *infrared images*, which show the amount of heat coming from the earth and the clouds. Infrared pictures reveal weather patterns even at night.

Communications satellites serve as *relay stations*, receiving radio signal messages from one location and transmitting them to another. These satellites are now an essential part of worldwide communications. A communications satellite can relay several television programmes or many thousands of telephone calls at once. Communications satellites are usually put in a high altitude, geosynchronous orbit over a *ground station*. A ground station has a large dish aerial for transmitting and receiving radio signals. Countries and commercial organizations such as television broadcasters and telephone companies use these satellites continuously.

Navigation satellites enable operators of aircraft, ships, and land vehicles anywhere on earth to determine their locations within 30 metres. These satellites send out radio signals that are picked up by a computerized receiver carried on a vehicle.

Navigation satellites operate in networks, and signals from a network can reach vehicles anywhere on the earth's surface. The receiver on board a vehicle calculates its distance from at least three satellites whose signals it has received. It then uses this information to determine the vehicle's location.

Earth observation satellites are used to map and monitor our planet's resources. They follow sun-synchronous, polar orbits. Under constant illumination from the sun, they take pictures in different colours of visible light and in infrared radiation. Computers on the earth combine and analyse the pictures. Scientists use earth observation satellites to locate mineral deposits, to determine the location and size of fresh water supplies, to identify sources of pollution and study its effects, and to detect the spread of disease in crops and forests.

Military satellites include weather, communications, navigation, and earth observation satellites used for military purposes. Some military satellites—often called "spy satellites"—can detect the launch of missiles, the course of ships at sea, and the movement of military equipment on the ground.

The life and death of a satellite

Building a satellite. Every satellite carries special instruments that enable it to perform its mission. For example, a satellite that studies the universe has a telescope. A satellite that helps forecast the weather carries cameras to film the movement of clouds.

In addition to such mission-specific instruments, all satellites have basic *subsystems*, groups of devices that help the instruments work together and keep the satellite operating. For example, a *power subsystem* generates, stores, and distributes a satellite's electric power. This subsystem may include panels of solar cells that gather energy from the sun. *Command and data handling subsystems* consist of computers that gather and process data from the instruments and execute commands from the earth.

A satellite's instruments and subsystems are designed, built, and tested individually. Workers install them on the satellite one at a time until the satellite is complete. Then the satellite is tested under conditions like those that the satellite will encounter during launch and while in space. If the satellite passes all tests, it is ready to be launched.

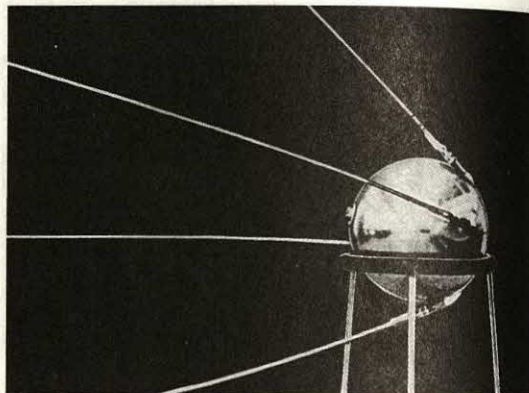
Launching the satellite. Space shuttles carry some satellites into space, but most satellites are launched by rockets that fall into the ocean after their fuel is spent. Many satellites require minor adjustments of their orbit before they begin to perform their function. Built-in rockets called *thrusters*—some as small as a propelling pencil—make these adjustments. Once a satellite is placed into a stable orbit, it can remain there for a long time without further adjustment.

Performing the mission. Most satellites operate under the direction of a *control centre* that is located on the earth. Computers and human operators at the control centre monitor the satellite's position, send instructions to its computers, and retrieve information that the satellite has gathered. The control centre communicates with the satellite by radio. Ground stations transmit and receive the radio messages. These stations are located beneath the satellite's orbit or elsewhere within the satellite's range.

A satellite does not usually receive constant direction from its control centre. It is like an orbiting robot. It controls its solar panels to keep them pointed toward the sun and keeps its aerials ready to receive commands. Its instruments automatically collect information.

Satellites in a high altitude, geosynchronous orbit are always in contact with the earth. Ground stations can contact satellites in low orbits as often as 12 times a day. During each contact, the satellite transmits information and receives instructions. Each contact must be completed during the time the satellite passes overhead—about 10 minutes.

If some part of a satellite breaks down, but the satellite remains capable of doing useful work, the satellite owner usually will continue to operate it. In some cases, ground controllers can repair or reprogram the satellite. In rare instances, space shuttle crews have retrieved and repaired satellites in space. If the satellite can no longer perform usefully and cannot be repaired or reprogrammed, operators from the control centre will send a signal to shut it off.



Sputnik 1, the first artificial satellite, was launched by the Soviet Union in 1957. It transmitted radio signals to earth.

Falling from orbit. A satellite remains in orbit until its velocity decreases and the gravitational force pulls it down into a relatively dense part of the atmosphere. A satellite slows down due to the friction of air particles in the upper atmosphere and the gentle pressure of the sun's energy. When the gravitational force pulls the satellite down far enough into the atmosphere, the satellite rapidly compresses the air in front of it. This air becomes so hot that most or all of the satellite burns up.

History

In 1955, the United States and the Soviet Union announced plans to launch artificial satellites. On Oct. 4, 1957, the Soviet Union launched Sputnik 1, the first artificial satellite. It circled the earth once every 96 minutes and transmitted radio signals that could be received on the earth. On Nov. 3, 1957, the Soviets launched a second satellite, Sputnik 2. It carried a dog named Laika, the first animal to soar in space. The United States launched its first satellite, Explorer 1, on Jan. 31, 1958, and its second, Vanguard 1, on March 17, 1958.

In August 1960, the United States launched the first communications satellite, Echo I. This satellite reflected radio signals back to the earth. In April 1960, the first weather satellite, Tiros I, sent pictures of clouds to the earth. The U.S. Navy developed the first navigation satellites. The Transit 1B navigation satellite first orbited in April 1960. By 1965, more than 100 satellites were being placed in orbit each year.

Since the 1970's, scientists have created new and more effective satellite instruments and have made use of computers and miniature electronic technology in satellite design and construction. In addition, more nations and some private businesses have begun to purchase and operate satellites. By the early 1990's, more than 20 countries owned satellites. About 2,000 satellites were operating in orbit.

Related articles in *World Book* include:

- Astronomy (Space exploration)
- Hubble Space Telescope
- Navigation (Satellite navigation)
- Orbit
- Remote sensing
- Rocket (Launching probes and satellites)
- Space exploration

Satie, Erik (1866-1925), a French composer, spent his entire career challenging established conventions in music. Satie was unconcerned about rules in music, and he especially disliked romanticism and impressionism. His unusual treatment of harmony and musical forms has influenced many composers.

Most of Satie's compositions are for the piano. His most popular work is one of his earliest, the first of his three *Gymnopédies* (1888). Many of his compositions contain humorous commentaries. They include *Sports and Entertainments* (1914) and *Bureaucratic Sonatina* (1917), which is a parody of a teaching piece by composer Muzio Clementi. Satie's eccentric sense of humour is reflected in his choice of titles, such as *Three Pieces in the Form of a Pear* (1903), *Truly Flabby Preludes for a Dog* (1911), and *Desiccated Embryos* (1913). His most famous large-scale compositions are the music for the ballet *Parade* (1917), which includes parts for a siren and typewriters, and the cantata *Socrate* (1919).

Eric Alfred Leslie Satie was born in Honfleur, near Le Havre. He changed his first name to Erik in 1888. For many years, he barely earned a living as a café pianist in Paris. He began to gain recognition as a composer after about 1910.

Satin is a weave in which the *weft* (crosswise yarns) do not cross the *warp* (lengthwise yarns) as often as in a plain weave. Satin also has no distinct diagonal pattern. Instead, the fabric is smooth and shiny. *Satin* also refers to silk, nylon, and rayon or cotton fabrics with a satin weave.

Satire is the use of irony or sarcasm to attack some form of human behaviour. Most satire appears in literature, but satire also plays a part in most other art forms. Most satirists claim they want to expose and reform such human failings as greed or vanity. But some satirists simply seem to enjoy ridiculing human conduct.

The art of satire was perfected by two ancient Roman writers, Horace and Juvenal. The gentle mockery of Horace and the bitter savagery of Juvenal have come to represent two of the main kinds of satire—*Horatian* (mild) and *Juvenalian* (bitter).

Satire appears in all national literatures. The comedies of Aristophanes satirize Greek society of the 400's B.C. François Rabelais' novel *Gargantua and Pantagruel* ridicules French political, religious, and social institutions of the 1500's. Nikolai Gogol poked fun at Russians of the 1800's in his novels and plays.

A great period of satire occurred during the late 1600's and early 1700's in English literature. Most of the important writers of this period wrote brilliant satiric works. For example, Alexander Pope's *The Dunciad* bitterly attacks the deterioration of culture, especially by bad literature and education. Perhaps the greatest work of satire in the English language is Jonathan Swift's *Gulliver's Travels*. It was adapted into a children's story, but Swift meant to satirize politics, science, and many other subjects.

The American cartoonists Al Capp, Jules Feiffer, Walt Kelly, and Garry Trudeau became famous for their satire. Leading satirists among artists include William Hogarth of England and Honoré Daumier of France. Preston Sturges of the United States directed many satirical films. Magazines devoted to satire have included *Punch* in England and *National Lampoon* in the United States.

In the mid-1900's, *black humour* largely replaced traditional satire. Black humour criticizes human behaviour but offers no hope for reform.

Related articles in *World Book* include:

Aristophanes
Daumier, Honoré
Dryden, John
France, Anatole
Gogol, Nikolai
Hogarth, William
Horace
Juvenal
Molière
Pope, Alexander
Rabelais, François
Sturges, Preston
Swift, Jonathan
Voltaire

Sato, Eisaku (1901-1975), served as premier of Japan from 1964 to 1972. Under his leadership, Japan emerged as a world power after World War II (1939-1945). As premier, he supported the United States-Japan Treaty under which the United States defends Japan. But he wanted Japan to assume more responsibility for its own defence. Ill health forced Sato to resign in 1972, and Kakuei Tanaka succeeded him. Sato and Sean MacBride of Ireland were awarded the 1974 Nobel Peace Prize. Sato won the award for his efforts to limit the spread of nuclear weapons.

Sato was born in Tabuse, a small town on the Inland Sea. He received a law degree from Tokyo University, and then joined the transportation ministry. During World War II, he directed the operation of the railways. Later, he became vice-minister of transportation.

Sato was elected to the *Diet* (parliament) in 1949. He served in a series of important party and Cabinet offices until 1954 when he and other top government officials were accused of taking bribes. They resigned. Sato returned to the government four years later in the Cabinet—under the leadership of his brother Kishi. He also served in Premier Ikeda's Cabinet. When Ikeda resigned because of illness, Sato was selected as premier.

Satrap was the governor of a *satrapy* (province) in the ancient Persian Empire. The satrap also was tax collector and chief judge of the province. Each satrap kept his own force of bodyguards. Satraps continued to rule after Alexander the Great conquered the empire in 331 B.C.

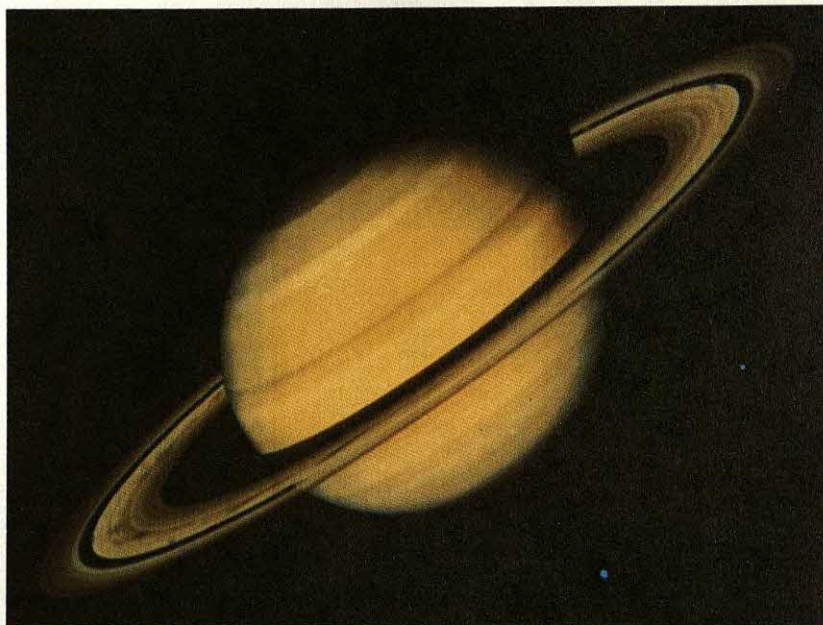
Saturable reactor. See **Magnetic amplifier**.

Saturation is a term used in chemistry and physics. Chemists say that a solution is *saturated* when no more of a substance will dissolve in it at the same temperature and pressure. *Saturation* is also a term used to describe the electronic structure of certain molecules. Saturated molecules do not have double or triple bonds. In *saturated organic molecules*, a single bond connects each carbon atom to four other atoms (see **Bond** [chemical]).

See also **Evaporation**.

Saturday, called *Saeter-daeg* by the Anglo-Saxons, is the seventh day of the week. It is named after the Roman god Saturn and is the only day named after a Roman god. Saturday is the Sabbath among the Jews and the Seventh-day Adventists. Most employers give their workers either a half holiday or a full holiday on Saturday.

See also **Week**.



Saturn is encircled by seven major rings. In the photograph on the left, a section of the rings is hidden by the shadow of the planet. The small object below Saturn is Rhea, one of its moons. Another moon, Dione, appears on the right.

Saturn was an early god in Roman mythology. The ancient Romans probably considered him the god of fertility and planting, but few myths about him remain. His name is probably Etruscan in origin. At first, Saturn had a separate identity. Later, the Romans identified him with the Greek god Cronus. Saturn's wife was Ops, the goddess of fertility and the harvest.

Each year, the Romans honoured Saturn with a festival called the Saturnalia. The festival began on December 17 and lasted seven days. During this period, schools and businesses closed, no criminals could be punished, and Roman armies could not start wars. Slaves and masters became equals. Most rules of public conduct were suspended, and entire communities engaged in wild celebration.

Some scholars believe that several modern Christmas customs came from the Saturnalia. These customs include feasting and giving gifts.

See also **Cronus**; **Saturnalia**.

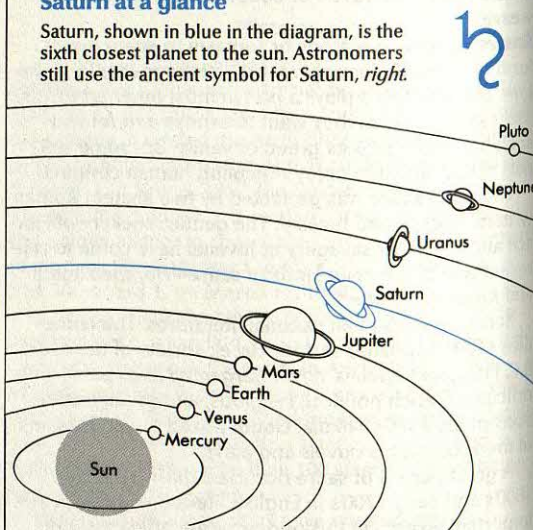
Saturn is the second largest planet. Only Jupiter is larger. Saturn has seven thin, flat rings around it. The rings consist of numerous narrow ringlets, which are made up of ice particles that travel around the planet. The gleaming rings make Saturn one of the most beautiful objects in the solar system. Jupiter, Neptune, and Uranus are the only other planets known to have rings. Their rings are much fainter than those around Saturn.

Saturn's diameter at its equator is about 120,540 kilometres, almost 10 times that of the earth. The planet can be seen from the earth with the unaided eye, but its rings cannot. Saturn was the farthest planet from the earth that the ancient astronomers knew about. They named it after the Roman god of agriculture.

Orbit. Saturn is the sixth closest planet to the sun. Its mean distance from the sun is about 1,429,400,000 kilometres, compared with about 150,000,000 kilometres for the earth. At its closest approach to the earth, Saturn is about 1,277,400,000 kilometres away.

Saturn at a glance

Saturn, shown in blue in the diagram, is the sixth closest planet to the sun. Astronomers still use the ancient symbol for Saturn, *right*.



Distance from sun: *Shortest*—1,349,900,000 km; *Greatest*—1,508,900,000 km; *Mean*—1,429,400,000 km.

Distance from earth: *Shortest*—1,277,400,000 km; *Greatest*—1,658,000,000 km.

Diameter: 120,536 km.

Length of year: About 29½ earth-years.

Rotation period: 10 hours 39 minutes.

Temperature: -178° C

Atmosphere: Hydrogen, helium, methane, ammonia, ethane, and phosphine (?).

Number of satellites: 18.

Saturn travels around the sun in an *elliptical* (oval-shaped) orbit. Its distance from the sun varies from about 1,508,900,000 kilometres at its farthest point to about 1,349,900,000 kilometres at its closest point. The planet takes about 10,759 earth-days, or about $29\frac{1}{2}$ earth-years, to go around the sun, compared with 365 days, or one year, for the earth.

Rotation. As Saturn travels around the sun, it spins on its *axis*, an imaginary line drawn through its centre. Saturn's axis is not *perpendicular* (at an angle of 90°) to the planet's path around the sun. The axis tilts at an angle of about 27° from the perpendicular position. See **Planet** (illustration: The axes of the planets).

Saturn rotates faster than any other planet except Jupiter. Saturn spins around once in only 10 hours 39 minutes, compared with about 24 hours, or one day, for the earth. The rapid rotation of Saturn causes the planet to bulge at its equator and flatten at its poles. The planet's diameter is 13,000 kilometres larger at the equator than between the poles.

Surface and atmosphere. Most scientists believe Saturn is a giant ball of gas that has no solid surface. However, the planet seems to have a hot solid inner core of iron and rocky material. Around this dense central part is an outer core that probably consists of ammonia, methane, and water. A layer of highly compressed, liquid metallic hydrogen surrounds the outer core. Above this layer lies a region composed of hydrogen and helium in a *viscous* (syruplike) form. The hydrogen and helium become gaseous near the planet's surface and merge with its atmosphere, which consists chiefly of the same two elements.

A dense layer of clouds covers Saturn. Photographs of the planet show a series of belts and zones of varied colours on the cloud tops. This banded appearance seems to be caused by differences in the temperature and altitude of atmospheric gas masses.

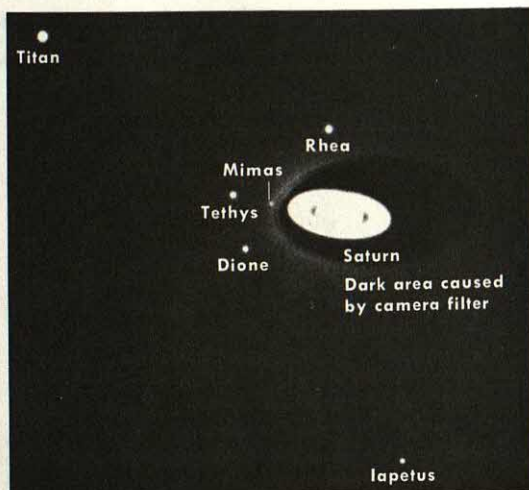
The plants and animals that live on the earth could not live on Saturn. Scientists doubt that any form of life exists on the planet.

Temperature. The tilt of Saturn's axis causes the sun to heat the planet's northern and southern halves unequally, resulting in seasons and temperature changes. Each season lasts about $7\frac{1}{2}$ earth-years, because Saturn takes about 29 times as long to go around the sun as the earth does. Saturn's temperature is always much colder than the earth's, because Saturn is so far from the sun. The temperature at the top of Saturn's clouds averages -178°C .

The temperatures below Saturn's clouds are much higher than those at the top of the clouds. The planet gives off about $2\frac{1}{2}$ times as much heat as it receives from the sun. Many astronomers believe that much of Saturn's internal heat comes from energy generated by the sinking of helium slowly through the liquid hydrogen in the planet's interior.

Density and mass. Saturn has a lower *density* than any other planet (see **Density**). It is only about one-tenth as dense as the earth, and about two-thirds as dense as water. That is, a portion of Saturn would weigh much less than an equal portion of the earth, and would float in water.

Although Saturn has a low density, it has a greater *mass* than any other planet except Jupiter (see **Mass**).



Saturn and six of its satellites can be seen in this telescopic photograph. The dark area around Saturn is caused by a camera filter used to reduce the bright light reflected by the planet. Titan, the largest of Saturn's satellites, is one of the few in the solar system known to have an atmosphere.

Satellites of Saturn

Name	Mean distance from Saturn in km	Diameter of satellite in km	Year of discovery
Titan	1,221,000	5,140	1655
Iapetus	3,559,000	1,440	1671
Rhea	528,000	1,530	1672
Dione	379,000	1,120	1684
Tethys	298,000	1,050	1684
Enceladus	240,000	500	1789
Mimas	188,000	390	1789
Hyperion	1,502,000	360*	1848
Phoebe	10,583,000	200	1898
Janus	151,000	100*	1980
Epimetheus	151,000	90*	1980
Helene	379,000	160	1980
Telesto	298,000	35†	1980
Calypso	298,000	35†	1980
Pandora	142,000	200	1980
Prometheus	139,000	220	1980
Atlas	137,000	30	1980
1990 S-1	133,000	19†	1990

*Diameter of long axis.

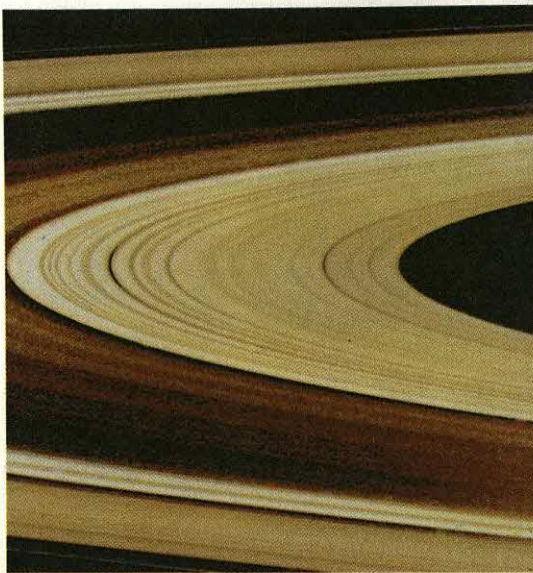
†Approximate diameter.

Saturn is about 95 times as massive as the earth. The force of gravity is a little higher on Saturn than on earth. A 45-kilogram object on earth would weigh about 48 kilograms on Saturn.

Rings. The rings of Saturn surround the planet at its equator. They do not touch Saturn. As Saturn orbits the sun, the rings always tilt at the same angle as the equator.

The seven rings of Saturn consist of thousands of narrow ringlets. The ringlets are made up of billions of pieces of ice. These pieces range from ice particles that are the size of dust to chunks of ice that measure more than 3 metres in diameter.

Saturn's major rings are extremely wide. The outermost ring, for example, may measure as much as



The dark side of Saturn's rings was photographed by *Voyager 1* as it flew by the side opposite the sun. The dense B-ring—the reddish-brown band—appears dark because it blocks much of the sunlight. It is the brightest ring when viewed from earth.

300,000 kilometres across. However, the rings of Saturn are so thin that they cannot be seen when they are in direct line with the earth. They vary in thickness from about 200 to 3,000 metres. A space separates the rings from one another. Each of these gaps is about 3,200 kilometres or more in width. However, some of the gaps between the major rings contain ringlets.

Saturn's rings were discovered in the early 1600's by the Italian astronomer Galileo. Galileo could not see the rings clearly with his small telescope, and thought they were large satellites. In 1656, after using a more powerful telescope, Christiaan Huygens, a Dutch astronomer, described a "thin and flat" ring around Saturn. Huygens thought the ring was a solid sheet of some material. In 1675, Jean Domenique Cassini, a French astronomer, announced the discovery of two separate rings made up of swarms of satellites. Later observations of Saturn resulted in the discovery of more rings. The ringlets were discovered in 1980.

Satellites. In addition to its rings, Saturn has at least 18 satellites. The largest, Titan, has a diameter of about 5,140 kilometres—larger than the planets Mercury and Pluto. Titan is one of the few satellites in the solar system known to have an atmosphere. Its atmosphere consists largely of nitrogen.

Many of Saturn's satellites have large craters. For example, Mimas has a crater that covers about one-third the diameter of the satellite. Another satellite, Iapetus, has a bright side and a dark side. The bright side of this satellite reflects about 10 times as much sunlight as the dark side. The satellite Hyperion is shaped somewhat like a squat cylinder rather than like a sphere. Unlike Saturn's other satellites, Hyperion's axis does not point toward the planet.

In 1980 and 1981, the Voyager space probes glimpsed what scientists believe are six additional small satellites

in orbit around Saturn. Scientists have made no further sightings of these satellites and so have not yet confirmed their existence.

Flights to Saturn. In 1973, the United States launched a space probe to study both Saturn and Jupiter. This unmanned craft, called *Pioneer-Saturn*, sped by Jupiter in 1974 and flew within 20,900 kilometres of Saturn on Sept. 1, 1979. The probe sent back scientific data and close-up photographs of Saturn that led to the discovery of two of the planet's outer rings.

Pioneer-Saturn also found that the planet has a magnetic field, which is 1,000 times as strong as that of the earth. This field produces a large *magnetosphere* (zone of strong magnetic forces) around Saturn. Data from the probe indicated the presence of radiation belts inside the planet's magnetosphere. The belts consist of high-energy electrons and protons, and are comparable to the earth's *Van Allen belts* (see *Van Allen belts*).

In 1977, the United States launched two space probes—*Voyager 1* and *Voyager 2*—to study Saturn and other planets. *Voyager 1* flew within 126,000 kilometres of Saturn on Nov. 12, 1980. On Aug. 25, 1981, *Voyager 2* flew within 101,000 kilometres of the planet.

The Voyager probes confirmed the existence of Saturn's seventh ring. They also found that the planet's rings are made up of ringlets. In addition, the probes sent back data and photographs that led to the discovery of nine satellites. The Voyager probes also determined that the atmosphere of Titan consists chiefly of nitrogen. In 1988, the European Space Agency, an organization of Western European nations, announced plans to launch an unmanned spacecraft to Saturn's moon Titan in 1996.

See also **Planet; Solar system.**

Saturn V. See **Space travel** (Launch vehicles).

Saturnalia was an ancient Roman festival that honoured Saturn, the god of agriculture. The Saturnalia began on December 17. It lasted two days at first, but eventually was extended to a week. The Saturnalia may have originated as a thanksgiving celebration to commemorate the winter planting. However, it later lost its agricultural significance and became a time of general merriment. Even slaves were given temporary freedom to do as they pleased. The Saturnalia featured feasting, visiting, and gift giving. The most popular gifts of this festival were wax candles and small clay figurines.

See also **Saturn** (Roman god).

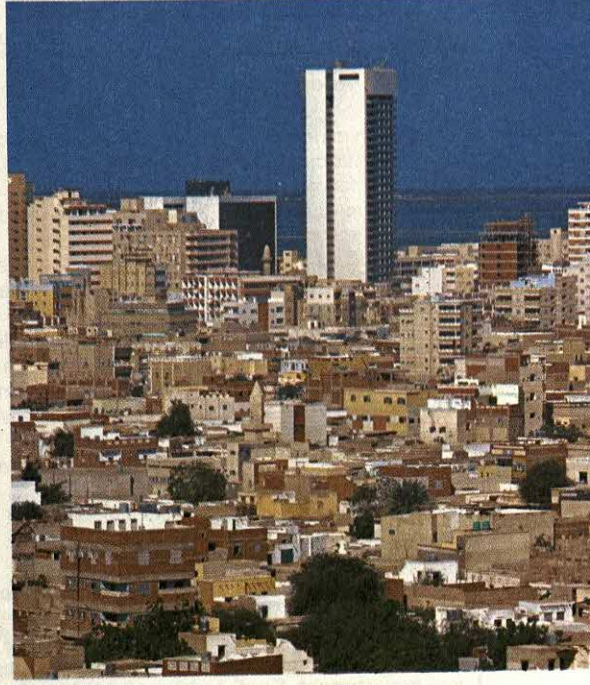
Satyr was a minor god of the countryside and woods in Greek mythology. Satyrs looked basically like ordinary human beings. But most of them had some animal features, such as goats' legs, hoofs, horns, and pointed ears, in a number of different combinations.

Satyrs followed Dionysus, the god of wine, and Pan, the god of woods and pastures. Most satyrs were young, playful, and mischievous. They sometimes became wild and uncontrolled but rarely harmed anyone. Their favourite occupations were drinking wine and pursuing lovely maidens called *nymphs*. They also enjoyed music and dancing. Some older satyrs, though drunkards, were considered extremely wise. The Roman word for a satyr was *faun*.

See also **Dionysus; Faun; Pan.**

Satyr play. See **Drama** (Greek drama).

Saucer, Flying. See **Unidentified flying object.**



Saudi Arabia has become a leading Middle Eastern nation since the development of its oil industry in the mid-1900's. Some of the world's largest oil fields lie beneath the desert in eastern Saudi Arabia, *left*. Oil wealth has promoted the growth of such cities as Jidda, *right*, a Red Sea port.

Saudi Arabia

Saudi Arabia is a large Middle Eastern nation that ranks as one of the world's leading producers of petroleum. Much of the country consists of vast deserts where few people live and little or nothing grows. But beneath the sand and rock of Saudi Arabia lie some of the largest petroleum deposits in the world.

Saudi Arabia exports more oil than any other nation. Wealth from these exports has made Saudi Arabia a leading economic power in the Middle East. Oil riches have also made Saudi Arabia a land of contrasts. Cars and trucks speed along highways where camel caravans once provided the only transportation. High-rise apartment buildings are replacing the mud houses that line city streets.

Saudi Arabia includes about three-quarters of the land region called the Arabian Peninsula. Coastal plains and rugged mountains cover the western part of Saudi Arabia. Most of the country's central and eastern areas consist of waterless plateaus and deserts. Parts of these regions have fertile oases.

Before the development of Saudi Arabia's oil industry after World War II (1939-1945), most of the people lived in rural areas. With the development of the oil industry, large numbers of people moved to cities and towns. Today, most Saudis live in urban areas. Most of the Saudis who live in rural areas are farmers or *nomadic* (wandering) herders who tend their camels, goats, and sheep. The urban people are employed in the oil indus-

try and in other occupations. Riyadh is the capital of Saudi Arabia.

Nearly all the people of Saudi Arabia are Arab Muslims. The country holds a place of special honour in the Muslim world. Mecca and Medina, the two holiest cities of Islam, are in Saudi Arabia. Thousands of Muslims from all over the world visit these cities on annual religious pilgrimages.

For hundreds of years, the land that is now Saudi Arabia was divided among many warring groups. The various regions joined together under the leadership of the Saud family during the early 1900's. The Kingdom of Saudi Arabia was proclaimed in 1932. Saudi Arabia re-

Facts in brief about Saudi Arabia

Capital: Riyadh.

Official language: Arabic.

Official name: Al-Mamlaka Al-Arabiyya Al-Saudiyya (Kingdom of Saudi Arabia).

Area: 2,149,690 km². *Greatest distances*—north-south, 1,843 km; east-west, 2,076 km. *Coastline*—1,889 km on the Red Sea; 549 km on the Persian Gulf.

Elevation: *Highest*—3,133 m above sea level, in the Asir region near Abha. *Lowest*—sea level.

Population: *Estimated 1996 population*—18,171,000; density, 8 people per km²; distribution, 77 per cent urban, 23 per cent rural. *1974 census*—7,012,642. *Estimated 2001 population*—21,295,000.

Chief products: *Agriculture*—poultry and eggs, dates, melons, milk, tomatoes, wheat. *Manufacturing*—cement, fertilizer, food products, petrochemicals, steel. *Mining*—petroleum.

Money: *Currency unit*—riyal. One riyal = 100 halalas.

remained a poor, backward nation until the mid-1900's, when income from the oil industry enabled the country to begin modernization programmes.

Government

National government of Saudi Arabia is a monarchy based on the laws of Islam. The king holds executive and legislative powers. He is both the chief political leader and *imam* (supreme religious leader). The country has no formal constitution. The *sharia*, the body of Islamic law, regulates most public affairs. The king issues royal decrees dealing with matters not covered by the *sharia*, such as traffic regulations.

The royal family consists of several thousand people and is the most important political group in Saudi Arabia. Leading members of the royal family select the king from among themselves. Their choice must be approved by a group of Muslim religious leaders called the *ulema*. To stay in power, the king must have the support of the royal family, the *ulema*, and local tribal leaders. The king appoints a Council of Ministers to assist him in managing the government. The king himself serves as prime minister.

In August 1993, the king appointed a 60-member Consultative Council to provide Saudi citizens with a voice in the government. The council's members can initiate laws and make general reviews of government policies.

Local government. Saudi Arabia is divided into 14 provinces. A governor appointed by the king heads each province. Provincial councils assist the governors. Several Saudi Arabian cities elect municipal councils that handle city government affairs. Smaller towns and villages are governed by local leaders.

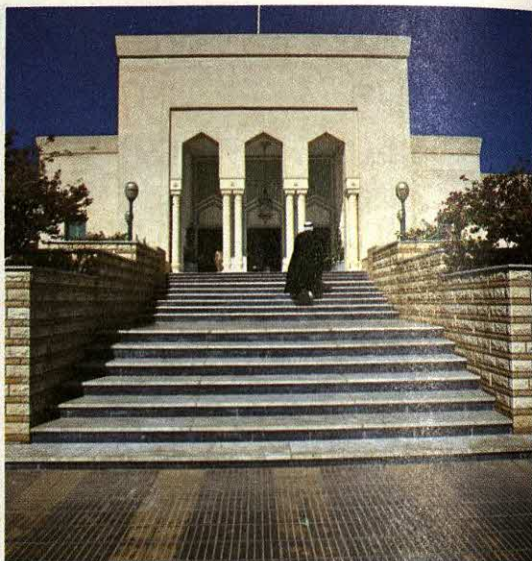
Courts. A system of religious courts handles all civil and criminal cases based on the *sharia*. A *qadi* (judge) presides over each court. There are no juries. Responsibility for the making of laws and enforcing them lies with the Council of Ministers and the king. A Grievance Board appointed by the king settles all complaints. The board also deals with problems of administration and taxation, and handles matters concerning foreign nationals and their commercial interests in Saudi Arabia.

Armed forces. A total of more than 55,000 men serve in Saudi Arabia's army, navy, and air force. All military service is voluntary. Saudi Arabia also has a National Guard of about 10,000 men. France, the United Kingdom, and the United States have provided Saudi Arabia with military training and equipment.

People

Population and ancestry. For Saudi Arabia's total population, see the *Facts in brief* table with this article. About three-quarters of the people are native Saudis. They are descended from people who settled in the Arabian Peninsula several thousand years ago. Other Saudis are people—or descendants of people—who arrived later. Many of these people or their ancestors first came to Saudi Arabia on pilgrimages before settling there permanently. All Saudis share the Arabic language and the Islamic religion.

Many other people who live in Saudi Arabia have moved there temporarily because of the large number of jobs created by the country's oil wealth. There are not enough qualified Saudis to fill all these jobs. About half



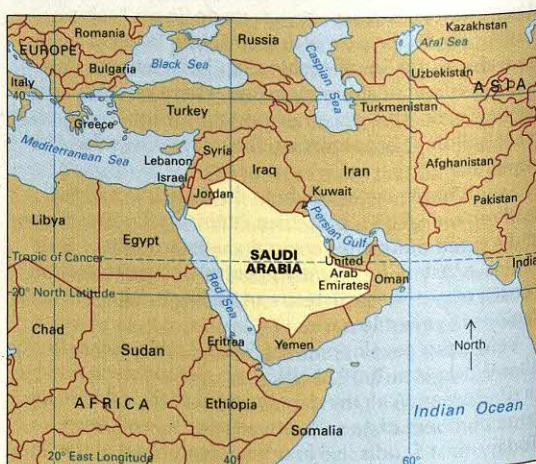
The Royal Palace in Jidda is one of several official residences of the king of Saudi Arabia. The king serves as head of state and of the government and is also the nation's religious leader.



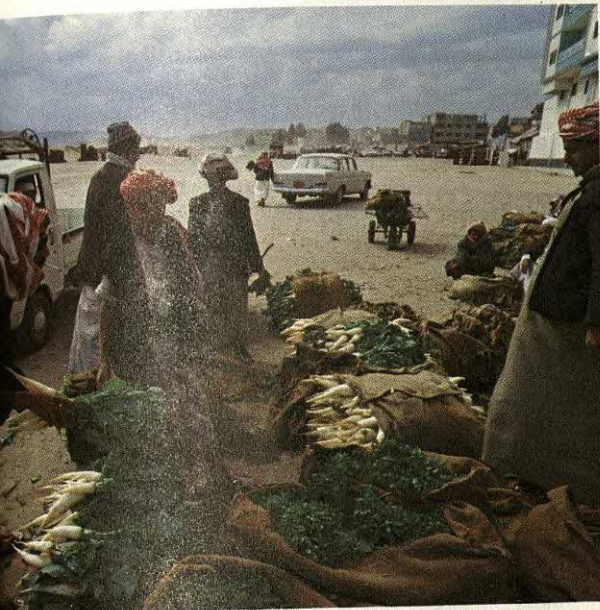
The flag of Saudi Arabia was adopted in 1973. It has a sword and a Muslim religious inscription written in Arabic.



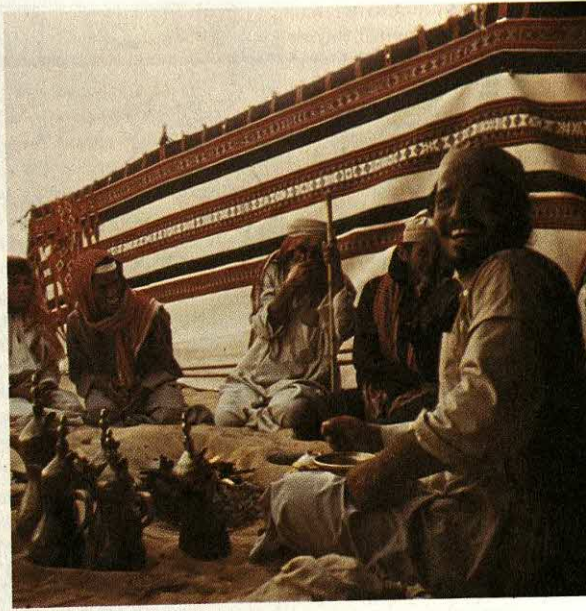
The coat of arms features a palm and two swords. The symbols appear in the traditional Muslim colour, green.



Saudi Arabia is a large Middle Eastern country. It covers most of the Arabian Peninsula from the Red Sea to the Persian Gulf.



Outdoor markets sell food and other products to Saudi shoppers. The men shown above, like most people in Saudi Arabia, wear headcoverings and long robes for protection from the sun.



The Bedouins of Saudi Arabia live in temporary campsites in the country's vast desert regions. These nomadic herders roam from place to place with their camels, goats, and sheep.

of the foreign workers are from other Arab countries. The rest came from many countries, including Pakistan, the Philippines, and South Korea.

About three-fourths of the people of Saudi Arabia live in urban areas. Riyadh ranks as Saudi Arabia's largest city. Jidda is the second largest city. The number of urban dwellers in Saudi Arabia has increased rapidly since the mid-1900's. Several new urban areas have developed near the oil fields in eastern Saudi Arabia. See **Jidda; Mecca; Medina; Riyadh.**

Language. Almost all the people of Saudi Arabia use Arabic, which is the official language of the country. English is taught in the secondary schools and is widely used among educated Saudis in business dealings and international affairs.

Religion. More than 90 per cent of all Saudis belong to the Sunni branch of Islam. Members of the Shiah, another branch, live mainly in the Eastern Province. The only non-Muslims in Saudi Arabia are foreigners.

Islam influences family relationships, education, and many other aspects of life in Saudi Arabia. Most Saudis recite prayers five times daily. Other religious rituals include fasting during Ramadan, the ninth month of the Muslim calendar. Each year, more than a million Muslims from Saudi Arabia and other countries go to Mecca on a religious pilgrimage. The pilgrimage is called the *hajj* (see *Hajj*).

Way of life. Many of Saudi Arabia's rural people live in farm villages or oasis settlements. The rest of the people are either nomads or seminomads. The nomads, called Bedouins, roam through the vast deserts with their herds of camels, goats, and sheep in search of water and pastureland. The seminomads follow a nomadic way of life part of the year but spend several

months in settled rural areas. Since the 1960's, many nomads and seminomads have become settled farmers or have moved to urban areas in order to work in the oil industry.

The development of the oil industry has caused many advances in the Saudi way of life, especially in the cities. Since the 1960's, the country has used much of its oil income to build modern schools, transportation systems, and communication networks. The government also has taken steps to improve housing and to extend electricity and other modern conveniences to Saudi Arabia's remote rural areas.

In spite of these improvements, most rural Saudis still follow a simple way of life. A typical farm village consists of a cluster of one- or two-room houses made of stones or sun-dried mud. The Bedouins, who move from place to place, live in large tents made of animal hides. The village marketplace serves as a social centre. There, farmers and Bedouins gather to buy and sell goods and chat with friends. Lively conversation is a favourite form of recreation for Saudis. The people enjoy telling stories and reciting poems or verses from the Quran, the sacred book of Islam.

In Saudi cities, modern apartment buildings have replaced many of the mud houses. Wealthy Saudis have large homes with spacious gardens. Radio and television have become popular forms of entertainment since the 1960's.

Family ties are strong among most Saudis. Although a Saudi father is considered the head of his family, his wife has much authority in running the household. Outside the home, Saudi women have traditionally had little freedom or opportunity for personal advancement. Before 1960, few women received any formal education,

Cities and towns

Abha	30,150	E	2
Ad Dam-			
mam	127,844	C	4
Ad Darb		E	2
Ad Dawadimi		C	3
Afil		C	2
Al Aqabah		E	2
Al Hufuf, see Hofuf			
Al Jawf		B	2
Al Jubayl		C	4
Al Khubar	48,817	C	4
Al Khurmah		D	2
Al Lith		D	2
Al Madinah, see Medina			
Al Maqnah		B	1
Al Mubarr-			
raz	54,325	C	4
Al Qadimah		D	2
Al Qatif	12,000	C	4
Al Qaysumah		B	3
Al Qunfudhah		E	2
Al Quwayiyah		C	3
Al Ula		C	1
Al Wajh		C	1
Ar Rass		C	3
Ar Rimah		C	3
Ar Riyadh, see Riyadh			
As Sulayyil		D	3
At Taif	204,857	D	2
At Turayf	10,000	A	2
Badanah	15,000	A	2
Buraydah	69,940	C	3
Dhahran		C	4
Hail	40,502	B	2
Hafj		B	1
Harad		C	4
Hofuf (Al)			
Hufuf	101,271	C	4
Jidda	1,210,000	D	2
Kaf		A	1
Khamis			
Mushayt	48,817	E	2
Khaybar		C	2
Khufi		C	3
Khurays		C	4
Layla		D	3
Makkah, see Mecca			
Mecca (Mak-			
kah)	463,000	D	2
Medina (Al)			
Madinah)	198,186	C	2
Najran	47,501	E	2
Qalat Bishah		D	2
Qizan	32,812	E	2
Rabigh		D	2
Rafha		B	3
Ras Tanura		C	4
Riyadh (Ar			
Riyad)	1,380,000	C	3
Tabuk	74,825	B	1
Tayma		B	1
Turabah		D	2
Umm Lajj		C	1
Unayzah	40,000	C	3
Yanbu		C	1

*Does not appear on map; key shows general location.
Sources: 1986 official estimates for cities with more than 300,000 people; 1974 census for other places.



and almost none worked outside the home. Since then, the government has improved educational and job opportunities for women. Increasing numbers of women work in such fields as teaching and nursing. They also work in businesses that deal only with other women. But the activities of women are still restricted. Saudi women are not allowed to drive cars or to demonstrate for changes of regulations concerning their rights.

A number of Saudi religious leaders have opposed changes that have occurred since the mid-1900's. For example, many opposed the introduction of television and the education of women. They believe such developments violate the teachings of Islam. Islam still has a strong influence over everyday life. But many Saudis, especially young people, believe the country can benefit from modernization without losing its basic traditional values.

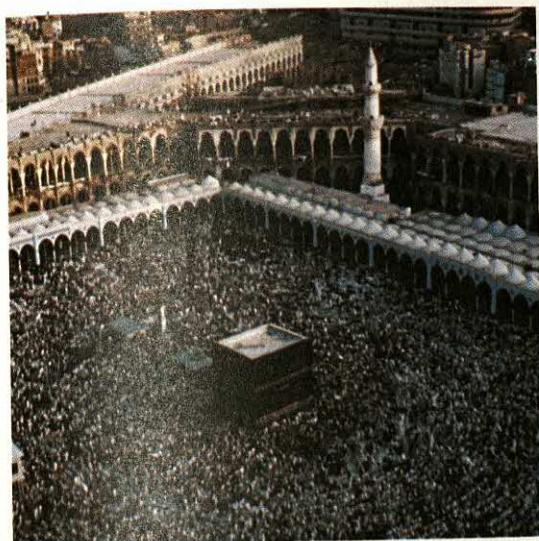
Food and clothing. Dairy products, dates, lamb, and rice are the chief foods of most Saudis. Farmers and city

dwellers also eat a variety of fruit and vegetables. Tea and coffee are the most popular beverages. The laws of Islam forbid the eating of pork and the drinking of alcoholic beverages.

Most Saudis, in both urban and rural areas, wear traditional Arab clothes. Men wear a long cotton garment called a *thawb*, which may be covered by a robe, jacket, or cloak. A headcovering called a *ghutra* provides protection against the sun and wind. It consists of a piece of cloth held in place by a rope band. Outside the home, most Saudi women cover their face with a veil and wear a floor-length robe called an *aba*.

Education. About half of the people of Saudi Arabia 15 years of age or older can read and write. Since the mid-1900's, the government has established adult education programmes and has built hundreds of new schools to improve the country's literacy rate.

The government provides free schooling for Saudi citizens at all levels of education. School attendance is



Islam has a strong influence on everyday life in Saudi Arabia. Muslims come from throughout the world to pray at the Great Mosque in Mecca, above. The cube-shaped building in the centre of the picture is the Kaaba, the most sacred shrine of Islam.

not required by law although it is vigorously encouraged. Saudi boys and girls attend separate schools. The first state schools for boys were established in 1926. Before that time, the country's only schools were religious institutions called *kuttab*s. The first state girls' schools opened in 1960. In 1953, the country had about 330 state primary and secondary schools. Today, there are about 11,500 schools with more than 2 million students. More than a third of the students are girls.

More than 90,000 students attend Saudi colleges or universities. Many other Saudis attend colleges or universities abroad, mostly in the United States. Saudi Arabia has seven universities.

Land and climate

Saudi Arabia covers 2,149,690 square kilometres, or about three-fourths of the Arabian Peninsula. The coun-

try consists largely of dry, barren land that slopes downward from west to east. There are no permanent rivers or other bodies of water in Saudi Arabia. During rainstorms, dry valleys called *wadis* fill with water, but the water quickly evaporates or soaks into the ground.

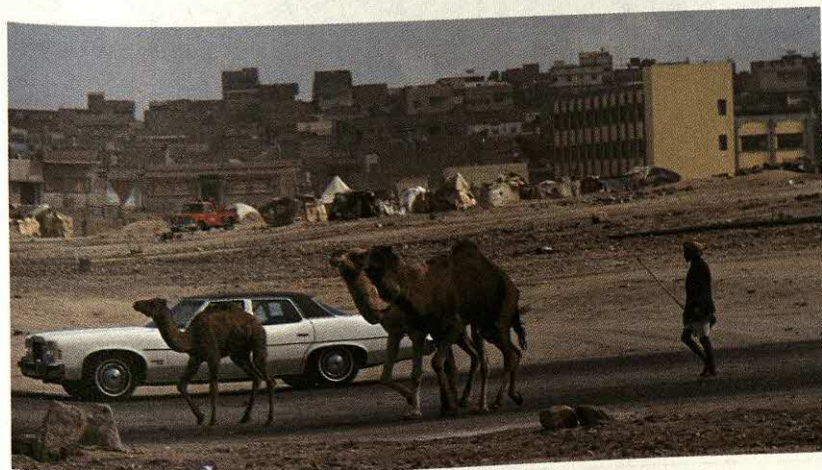
Saudi Arabia can be divided into five land regions. They are: (1) the Western Highlands, (2) the Central Plateau, (3) the Northern Deserts, (4) the Rub al Khali, and (5) the Eastern Lowlands.

The Western Highlands border the Red Sea. The northern part of this region is called Hejaz, and the southern part is called Asir. Along much of the Hejaz coast, low, rocky mountains rise up sharply from the sea. The mountains slope more gently toward the east. In parts of Hejaz and in Asir, a narrow coastal plain called the Tihamah separates the sea from a ridge of rugged mountain peaks. The highest peaks in Asir rise more than 2,700 metres above sea level. Asir is the most fertile area of Saudi Arabia, and small farm villages are scattered throughout much of this region. Farmers grow a variety of crops in the Tihamah and in terraced fields on the mountainsides.

The Central Plateau. The mountains of Hejaz and Asir slope eastward toward a large region called the Central Plateau, or Najd. Most of the region has little vegetation. In parts of the rocky plateau, fertile oases support small farm communities. Riyadh is the largest city in the Central Plateau region. Nomadic herders bring their animals to feed on patches of grass that grow in the region for a short time after occasional brief periods of rainfall.

The Northern Deserts lie north of the Central Plateau. Most of this thinly populated region consists of a vast area of sand dunes called An Nafud. The Syrian Desert, a low-lying plain of rock and gravel, covers the northernmost area.

The Rub al Khali is a huge sandy desert that covers about 647,500 square kilometres of southern Saudi Arabia. This vast, desolate area, whose name in English is the Empty Quarter, is about five times the size of England. Windswept sand dunes reach heights of nearly 300 metres in parts of the Rub al Khali. Other areas are flat. The Rub al Khali is uninhabited, except for a few groups of nomadic people who travel through it.



Old and new ways of life exist side by side in Saudi Arabia. Modern apartment buildings are replacing mud houses in many Saudi cities and towns, and cars share roads with teams of camels.



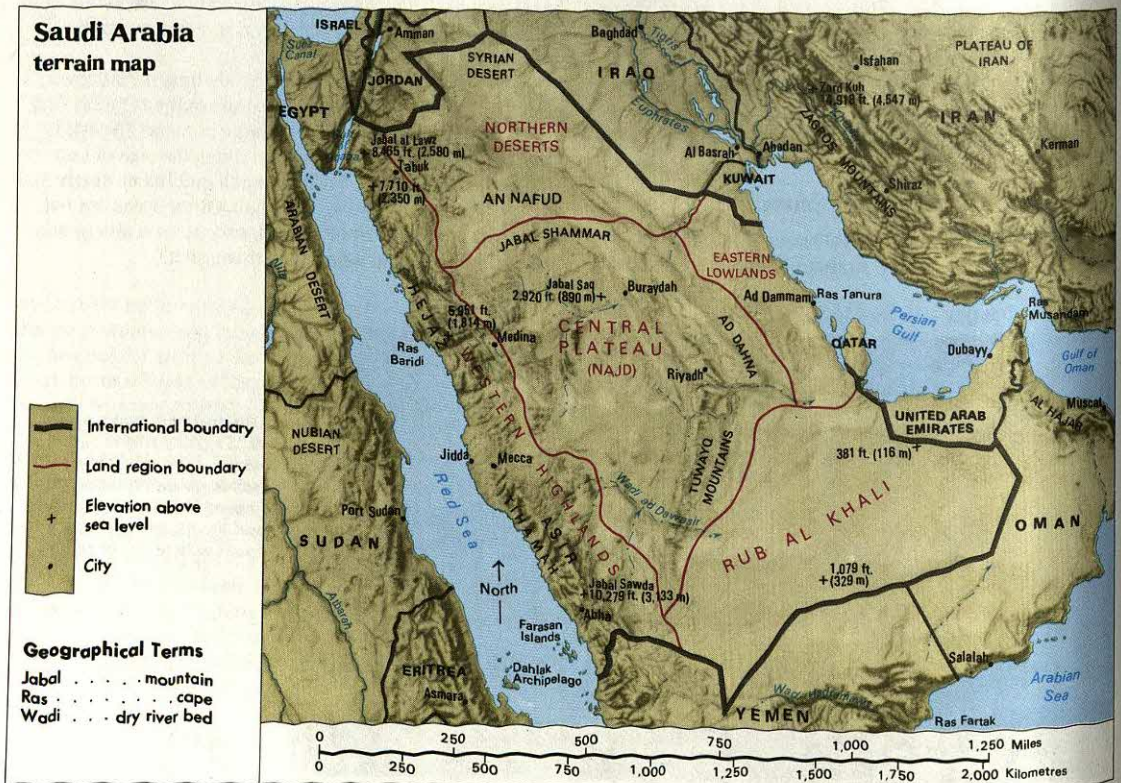
The Asir region of southwestern Saudi Arabia is the country's most fertile area. Saudi farmers use terraced fields to grow crops on the hills and mountains that cover much of the region.

The Eastern Lowlands, also known as Hasa or the Eastern Province, lie along the Persian Gulf. Salt flats extend along parts of the shallow coastline. Sand and gravel cover most of the inland plain, which contains the world's largest known deposits of petroleum. The oil industry has led to the development of Dhahran and several other cities and towns in the lowlands. The region also has a number of fertile oases that support large agricultural settlements.

Climate. Most of Saudi Arabia has a year-round hot climate. The coastal regions are hot and humid during the summer, when the average daytime temperature is over 32° C. Summer temperatures in the Central Plateau

and the desert regions may reach 49° C. But these areas have drier air and cool nights. From November to April, temperatures throughout the country are slightly lower than in summer. Winter temperatures in parts of the country can be very much colder. Parts of central, northern, and western Saudi Arabia occasionally dip below freezing.

Asir is the only part of Saudi Arabia that receives much rainfall. Summer *monsoons* (seasonal winds) cause an average annual rainfall in Asir of from 30 to 51 centimetres. The rest of the country receives less than 10 centimetres annually. Parts of the desert regions of Saudi Arabia may have no rainfall at all for several



years in a row. A northwesterly wind called the *shamal* causes frequent and severe sandstorms in eastern Saudi Arabia.

Economy

Saudi Arabia has a rapidly developing economy, based largely on the oil industry and agriculture. The oil industry accounts for about 40 per cent of Saudi Arabia's economic production. Agriculture accounts for only a small share of Saudi Arabia's economic production. In the 1980's, however, the government encouraged agricultural expansion. As a result, wheat production increased to 3 million metric tons in 1987 from a total of a mere 30,000 metric tons in 1977.

Since the 1960's, the government has worked to develop new industries in Saudi Arabia. Such industries would allow the country's economy to keep growing even after the oil resources have been used up. The government of Saudi Arabia has worked on development programmes with the help of business and technical experts from Europe, Japan, the United States, and other parts of the world. A shortage of skilled Saudi workers has delayed the progress of some of these development programmes.

Natural resources. Petroleum is by far Saudi Arabia's most important natural resource. The country's huge oil fields contain about 165 billion barrels of oil—about a quarter of the world's known oil reserves. The oil fields lie in the eastern part of the country and in the Persian Gulf. Newly discovered oil fields lie in the Al Hora region and other areas near Riyadh. Saudi Arabia also has small deposits of copper, gold, iron ore, silver, and other minerals. But few of these deposits have been developed.

The oil industry is Saudi Arabia's chief source of wealth. Saudi Arabia exports more petroleum than any other country. It ranks second only to Russia in petroleum production. Saudi Arabia is a leading member of the Organization of Petroleum Exporting Countries (see

Organization of Petroleum Exporting Countries). Petroleum and petroleum products account for about 40 per cent of Saudi Arabia's total economic production. But the oil industry employs only about 2 per cent of all Saudi workers.

Other industries. Money spent by people who visit Saudi Arabia is another source of income. Most of the visitors are Muslims who go to the country on religious pilgrimages. The construction industry has grown since the 1960's, when thousands of Saudis began working on government-sponsored building projects.

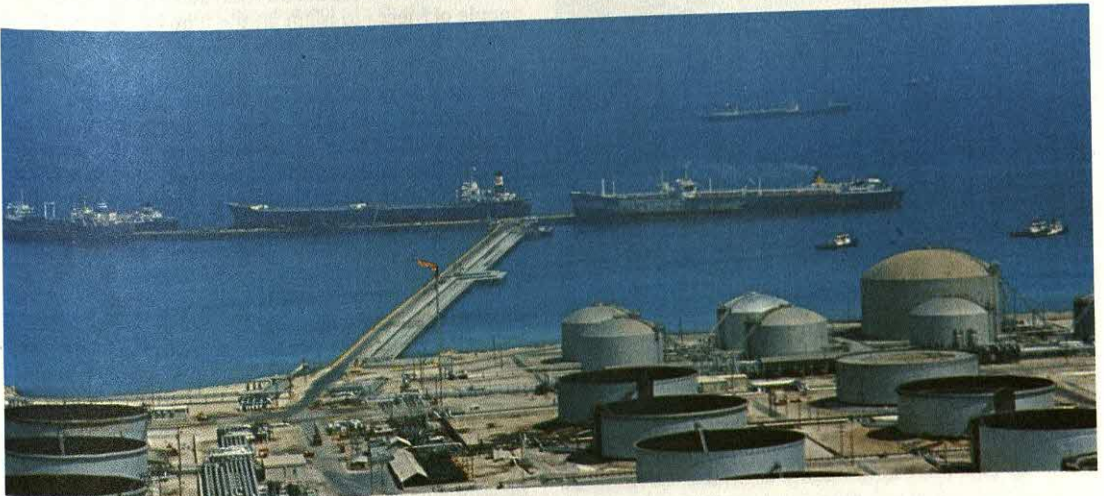
Saudi Arabia does not have many manufacturing industries. The country's chief manufactured goods include cement, fertilizer, food products, *petrochemicals* (chemicals made from petroleum), and steel.

Agriculture, including the herding done by nomads and seminomads, employs about a quarter of all Saudi workers. Cattle, goats, and sheep are important sources of dairy products and meat. Chickens and eggs are also produced. Only about 1 per cent of Saudi Arabia's land is used to grow crops. The chief cultivated areas include Asir in the southwest and the scattered oases of central and eastern Saudi Arabia.

Farmers grow such crops as dates, melons, tomatoes, and wheat. Dates formerly ranked as the chief crop. However, the introduction of modern irrigation techniques during the mid-1900's enabled Saudi farmers to produce more, and a greater variety of, crops. As a result of an ambitious agricultural programme, 854,000 hectares were put under cultivation in 1987. This enabled Saudi Arabia to begin the export of poultry and allied products to the Gulf states, and wheat to several other countries.

Saudi Arabia has only a small fishing industry. Shrimp caught in the Persian Gulf are the only important seafood product.

Transportation and communication. Since the mid-1960's, Saudi Arabia has expanded its transportation and communication networks. A good road system con-



The oil port of Ras Tanura lies on the Persian Gulf, near Saudi Arabia's huge petroleum deposits. Petroleum accounts for almost all Saudi exports, and most of it is shipped from Ras Tanura. Huge storage tanks hold the oil until it is pumped into ships docked offshore.

nects various parts of the country. A railway system operates between Riyadh and the Persian Gulf port of Ad Dammam. The government owns and operates Saudi Arabian Airlines. International airports are located at Dhahran, Jidda, and Riyadh. Ras Tanura, a Persian Gulf port, handles most of Saudi Arabia's oil exports. The country's other major ports include Ad Dammam and the Red Sea ports of Jidda and Yanbu.

Saudi Arabia has about 13 daily newspapers. Three of the newspapers are published in English, the others in Arabic. Most Saudi families own at least one radio and television set. A telephone network serves about 90 per cent of the country.

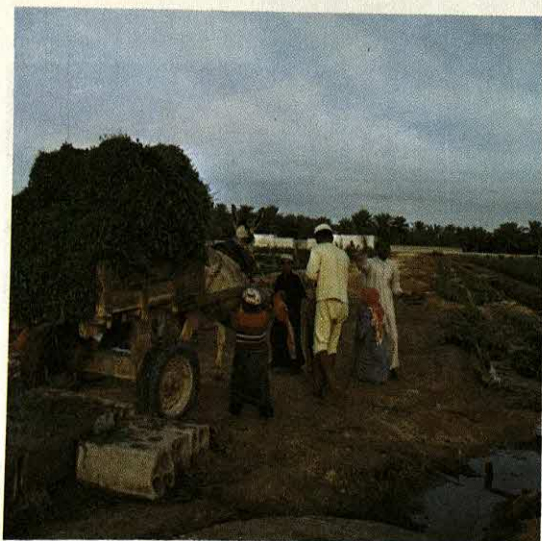
Foreign trade. Petroleum accounts for about 86 per cent of Saudi Arabia's exports. Most of the oil goes to Japan and Western Europe. The United States also buys large amounts of Saudi oil. Saudi Arabia also exports shrimp. Leading imports include food products, machinery, military equipment, and transportation equipment. The United States, Western Europe, and Japan provide most of the imported goods.

History

Various Semitic peoples lived in what is now Saudi Arabia several thousand years ago. Bedouins occupied the interior of the Arabian Peninsula. Other peoples established trade centres along caravan routes. These routes linked the Arabian Peninsula with other parts of the Middle East.

A people called the Sabaeans inhabited what are now southwestern Saudi Arabia and western Yemen around 700 B.C. The Sabaeans became prosperous traders of frankincense, myrrh, and spices. Another group, the Nabataeans, controlled the trade routes in what are now northwestern Saudi Arabia and Jordan from the mid-400's B.C. to about A.D. 100.

The rise of Islam. Muhammad, the prophet of Islam, was born in Mecca about A.D. 570. At that time, most of



Farmers in the oases of Saudi Arabia rely on irrigation to grow fruit, grain, vegetables, and other crops. Only about 1 per cent of Saudi Arabia's total area is used as cropland.



A suq (bazaar) in Saudi Arabia usually groups sellers of similar wares together. This shop, selling pots, pans, and cooking utensils, is in a permanent market in Riyadh.

the people of the Arabian Peninsula worshipped many gods. Muhammad worshipped one God. In Mecca, many people opposed Muhammad. In 622, he and his followers went to Medina. He returned with an army and captured Mecca in 630. Muhammad converted the people of Mecca to Islam. By the time he died in 632, much of Arabia was under Muslim rule.

The decline of Arabia. During the mid-600's, Muhammad's successors, called *caliphs*, conquered large amounts of territory to the east, west, and north of Arabia. About 660, the caliph Muawiya moved his capital from Medina to Damascus, in Syria. The Arabian Peninsula then began to decline in importance as the political and religious centre of the Muslim empire.

Beginning about 750, the Muslim empire broke up into individual states. For more than a thousand years, numerous warring groups of people controlled the various areas that make up most of Arabia. During the early 1500's, the Ottoman Turks gained control over Hejaz and parts of Asir in western Arabia. Britain established protectorates along the southern and eastern coasts of Arabia during the 1800's. But local Arabian leaders still ruled most of the vast inland region.

The Saud dynasty. During the mid-1400's, the Saud dynasty (family of rulers) established control over a small area around the town of Dariyah, near what is now Riyadh. The dynasty remained relatively unimportant until the mid-1700's. At that time, the Saudi ruler, Mu-

Jidda, one of Saudi Arabia's largest cities and busiest ports, was under Turkish rule when Solomon Malan painted this watercolour in about 1850. The port was originally developed as an entry point for Muslim pilgrims to the holy cities of Mecca and Medina. Jidda is now also a major business, industrial, and diplomatic centre.



hammad ibn Saud, formed an alliance with a religious reformer named Muhammad ibn Abd al-Wahhab.

Ibn Abd al-Wahhab strongly opposed a growing disregard of Islamic teachings in Arabia. He preached that the people should return to a strict observance of Muslim laws. The Wahhabi movement, supported by Saudi armies, quickly spread over most of Arabia.

The Saud family enlarged the Saudi state by taking over the regions that were converted to Wahhabi beliefs. By the early 1800's, they had captured Mecca and

Medina. The Ottoman governor of Egypt then attacked the Saudi state to stop its expansion. Ottoman troops occupied the Hejaz region in 1814. In 1818, they occupied the Najd region and captured the Saudi capital of Daryah. The Saud family set up a new capital at Riyadh in 1824 and fought to regain its lost land. By 1843, Saudi armies had regained control of most of Arabia.

After 1865, family feuds led to civil war and the weakening of Saudi power. As a result, stronger tribes captured Saudi territory. By 1891, control over most of Arabia was divided among various tribal chiefs and the Ottomans. The leading members of the defeated Saud family fled into exile in Kuwait.

The founding of Saudi Arabia. In 1902, Abd al-Aziz ibn Saud, a young Saudi leader, led a military raid from Kuwait. He succeeded in capturing Riyadh. During the next 25 years, Ibn Saud fought to regain the territory that his ancestors had controlled and to revive the Wahhabi movement.

By 1906, Ibn Saud had taken control of the Najd region. His forces captured Hasa in 1913 and Asir in 1920. In 1925, he conquered Hejaz. Ibn Saud then unified the four regions. In 1932, he proclaimed the union the Kingdom of Saudi Arabia.

The new kingdom formed by Ibn Saud was isolated and undeveloped. Most of the people were poor farmers or nomads who lived much as their ancestors had lived for hundreds of years before them.

The development of Saudi Arabia's oil industry began in 1933. That year, Ibn Saud's government granted Standard Oil of California, an American oil company, the right to explore for and produce oil in Saudi Arabia. Other oil firms joined the California company. This group of companies became the Arabian American Oil Company (Aramco) in 1944. A major oil deposit was discovered in Saudi Arabia in 1938, but large-scale petroleum production did not begin until after World War II ended in 1945.

Important dates in Saudi Arabia

- c. 570** Muhammad, prophet of Islam, was born in Mecca.
- Mid-1400's** The Saud family established control over a small area around Daryah, near present-day Riyadh.
- Mid-1700's** The Wahhabi movement, which urged strict observance of Islamic laws, spread across most of Arabia. The Saud family supported the movement and took over regions converted to Wahhabi beliefs.
- 1891** Tribal chiefs and the Ottomans gained control of most of Arabia. Leading members of the Saud family fled in exile.
- 1906-1932** Abd al-Aziz ibn Saud, an exiled Saudi leader, conquered the Najd, Hasa, Asir, and Hejaz regions and formed the Kingdom of Saudi Arabia.
- 1933** The Saudi Arabian petroleum industry began.
- 1953** Ibn Saud died and was succeeded by his son Saud.
- 1964** Saud was forced to give up the throne and was succeeded by his brother Faisal.
- 1967** Saudi Arabia supported Egypt, Jordan, and Syria in the Six-Day War against Israel.
- 1973** Saudi Arabia stopped or reduced oil shipments to some Western nations after another Arab-Israeli war broke out.
- 1975** Faisal was assassinated. He was succeeded by his half brother Prince Khalid.
- 1982** Khalid died and was succeeded by his half brother Prince Fahd.
- 1991** Saudi Arabia and a coalition of other nations defeated Iraq in the Persian Gulf War.



Riyadh, the capital and largest city of Saudi Arabia, is the main headquarters of the country's vast oil industry and has become a world business centre. New ideas in architectural design and construction, as in the offices and shopping mall, *left*, have made Riyadh a city of glistening modernity.

After the war, the oil industry developed rapidly and brought wealth to Saudi Arabia. Aramco paid the Saudi government a share of its oil profits in return for the right to produce and sell oil. Ibn Saud began programmes of economic and social development in Saudi Arabia. The Saudi government and Aramco built roads, schools, and hospitals throughout the country.

Saudi Arabia became a charter member of the United Nations in 1945. It became a charter member of the Arab League the same year.

In 1953, Ibn Saud organized a Council of Ministers as a step toward modernizing the government. He named his oldest son, Saud, as his successor. Later that year, Ibn Saud died, and Saud became king. Saud's brother Faisal became crown prince and prime minister.

Saud continued the development programmes begun by his father. But Saud was a poor financial manager, and his government spent money unwisely. This led to serious economic problems by the late 1950s. In 1958, Saud gave Faisal control over the government. Faisal restored economic stability. But he resigned as prime minister in 1960 because of disagreements with Saud. Saud again took control of the government.

In 1962, a civil war in Yemen (Sana) caused a crisis between Saudi Arabia and Egypt. Yemeni military leaders had overthrown their government and set up a republic. Egypt supported these rebels, while Saudi Arabia backed Yemeni royalists who fought to restore the government. The conflict threatened to become a war between Saudi Arabia and Egypt. Tension continued until 1967, when Egypt withdrew its forces from Yemen.

During the early 1960s, Saud's health weakened, and with it his ability to rule. In 1962, Faisal again became prime minister. That year, Faisal announced a large-scale reform programme. He planned to reorganize local governments, promote industrialization, and introduce such new developments as television to Saudi Arabia. In 1964, a council of royal family members and reli-

gious leaders forced Saud to give up the throne. They then made Faisal king.

Faisal's rule brought continued progress to Saudi Arabia. Profits from the oil industry financed the construction of modern hospitals, schools, and apartment buildings. The government improved and expanded the country's transportation and communication systems. At the same time, Saudi Arabia began to take a more active interest in Arab and world affairs.

In 1967, Saudi Arabia supported the Arabs of Egypt, Jordan, and Syria in the Six-Day War against Israel. Saudi Arabia did not send troops. But after the Arabs lost the war, Saudi Arabia promised to give Egypt and Jordan financial aid to help them recover.

The Six-Day War left Israel in control of large sections of Arab territory. This land included part of Jerusalem, one of Islam's holiest cities. During the early 1970s, Faisal took a strong stand against this Israeli occupation. After another Arab-Israeli war broke out in 1973, Faisal used Saudi Arabia's oil as an economic weapon against supporters of Israel. Saudi Arabia and several other Arab countries temporarily stopped exporting oil to the United States and the Netherlands. They also sharply reduced oil shipments to other countries that they classed as "neutral." The oil cutback created serious fuel shortages in many countries.

In 1973, the Saudi Arabian government took over part-ownership of Aramco's oil facilities. In 1974, the government and Aramco began negotiating for Saudi Arabia to assume full control of the country's oil industry. In 1980, the Saudi Arabian government completed payment for ownership of Aramco's oil facilities and assets. However, the Saudi government did not sign the final agreement for the complete take-over.

In the mid-1970s, oil prices jumped sharply, causing a dramatic increase in Saudi Arabia's wealth. The added income enabled the government to devote huge sums of money to new projects.

Recent developments. In March 1975, King Faisal's reign ended abruptly when one of his nephews assassinated him. Prince Khalid, a half brother of Faisal, succeeded Faisal as king and prime minister. Khalid made his half brother, Prince Fahd, crown prince and first deputy prime minister. Khalid died in 1982, and Prince Fahd became king and prime minister.

Generally, Khalid and Fahd continued Faisal's policies. Saudi Arabia continued to take an active role in Arab and world affairs. Rapid construction of transportation and communication facilities continued, and industry expanded. But a sharp decline in worldwide oil prices reduced the country's income. The government began to put more emphasis on developing human resources and less on constructing physical facilities. These policies included steps to increase the training of Saudi's people in skills needed for management and technical jobs.

In August 1990, Iraqi forces invaded and occupied Kuwait. Many people feared that Iraq would next invade Saudi Arabia. Saudi Arabia requested assistance in defending its territory. In response, the United States and other Western nations sent military forces to Saudi Arabia. Egypt, Syria, and other Arab nations also sent forces. In January 1991, war broke out between these allied nations and Iraq. During the war, Saudi and other allied planes bombed military targets in Iraq and Kuwait. Saudi forces also took part in the ground offensive that liberated Kuwait in February. See **Persian Gulf War**.

Related articles in *World Book* include:

Arab League	Fahd	Kaaba
Arabian Desert	Faisal	Khalid
Arabian Peninsula	Food (picture)	Mecca
Arabs	Ibn Saud	Medina
Bedouins	Ikhwan	Muhammad
Clothing (picture:	Islam	Petroleum (graph)
Traditional costumes)	Jidda	Riyadh

Outline

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IV. Economy

- | | |
|----------------------|-------------------------------------|
| A. Natural resources | E. Transportation and communication |
| B. The oil industry | F. Foreign trade |
| C. Other industries | |
| D. Agriculture | |

V. History

Questions

- What is the English name for the Rub al Khali?
- When did the oil industry begin to develop rapidly in Saudi Arabia? How has this industry affected the nation?
- What is Saudi Arabia's most fertile region?
- What was the Wahhabi movement?
- What role does Islam play in Saudi life?
- What is an *aba*? a *wadi*? a *ghutra*?
- What is Saudi Arabia's chief natural resource?
- When was the Kingdom of Saudi Arabia officially proclaimed?
- Why is the *sharia* important in Saudi Arabia's government?
- What are Saudi Arabia's chief manufactured products?

Sauerkraut. See Germany (Food).

Saul was the first king of Israel and one of the most tragic figures in history. He reigned from about 1020 to about 1000 B.C. The dramatic story of his life and times is contained in the Old Testament (I Sam. 9-31).

Israel's existence as a nation was threatened by the Philistines, who had mastered the new technique of fabricating iron and had a monopoly of iron weapons. Israel's old system of government under casually chosen judges was not equal to the situation. The people clamoured for a king, and the old ruling group reluctantly gave in and picked Saul for the task. At this time, he was only a young member of an insignificant clan.

Saul surprised everybody with his ability. He was brave, generous, and modest, and he would not take orders blindly from the old guard. But the mounting pressures and responsibilities of ruling slowly undermined his personality. He became moody and suspicious, and grew jealous of young David's growing popularity.

Saul won many victories, but when the final test came, at the battle of Mount Gilboa, his outnumbered and poorly equipped army was no match for the Philistines. Mortally wounded, he fell on his sword. He was mourned by friend and foe alike. See also **David**.

Saul of Tarsus. See Paul, Saint.

Sauna is a special kind of bath for cleansing and relaxation. It causes perspiration by means of dry heat. The word *sauna* also refers to the room or bathhouse in which people take such a bath. Sauna has been a tradition in Finland for more than 1,000 years. Elsewhere, it is a feature of many health clubs, hotels, and resorts.

In a sauna, stones are heated on top of a furnace. The temperature in the room ranges from 80° to 100° C. Bathers sit or lie on wooden benches and perspire freely. They may pour water on the rocks to produce steam and make the sauna feel hotter. Next, the bathers take a cold shower or swim and then may repeat the entire process several times. Finally, they rest until their body temperature returns to normal.

The sauna process rids the body of dirt and grime more thoroughly than ordinary washing. It also may produce a soothing, healthy feeling. However, elderly people and individuals with a history of ill health should consult a doctor before using a sauna.

Saurischian. See Dinosaur.

Sauropod. See Dinosaur.

Sausage is a food made of chopped and seasoned meat. The meats used in making sausage include beef, game, pork, poultry, veal, and—in some countries—fish. Sausage is seasoned with herbs and spices, including salt, red and black pepper, sage, garlic, onions, sugar, and ginger. Most sausages contain some kind of cereal, which acts as a binder, and small amounts of curing agents called *nitrites*. Nitrites give sausages their colour and also help prevent the growth of bacteria that cause a type of food poisoning called *botulism*. Europeans sometimes add gin or red wine to the sausage they make in order to give it a special flavour.

Most sausage meat is pressed into a long, round casing (skin). Natural casings are made from the intestines of farm animals, especially sheep. Before these casings are used, they are carefully cleaned and salted, or soaked in brine. Casings made of cellulose materials are often used today (see **Cellulose**). Skinless frankfurters are sausages that have their casings removed.

Sausage meat and sausages are important products of the packing industry. In many countries, sausage is also made at home. Fresh sausages are sold raw and may be boiled, fried, or grilled. Other types of sausage include uncooked smoked sausages, such as country-style sausage links; cooked sausages, such as frankfurters; semi dry sausages, such as salami; dry sausages, such as pepperoni; and speciality meats, such as luncheon meats.

The frankfurter, named after Frankfurt (am Main), Germany, is the most popular sausage in the world. It is made of cured and well-smoked pork and beef. Experts believe frankfurters were first made in Germany during the Middle Ages. Frankfurters are also called *hot dogs*, *red hots*, and *wieners* in America. Frankfurters served in buns are a favourite American food. Vienna sausage, or *wienerwurst*, looks like a frankfurter but is shorter. It is named after Vienna (Wien), Austria.

See also **Meat processing** (picture: A frankfurter machine).

Sauvé, Jeanne Mathilde (1922-1993), was governor general of Canada from 1984 to 1990. She succeeded Edward Schreyer. Sauvé was the first woman to serve as governor general in Canada.

Sauvé was born in Prud'homme, Saskatchewan, Canada. She graduated from Notre Dame du Rosaire Convent, a college in Ottawa, and also studied at the University of Paris. In 1950, she began working for UNESCO, an agency of the United Nations. From 1952 until 1972, she worked mainly as a journalist and broadcaster for newspapers and radio and television networks in Canada. In 1972, Sauvé was elected to the House of Commons. Prime Minister Pierre Trudeau appointed her minister of state for science and technology in 1972, minister of the environment in 1974, and minister of communications in 1975. Sauvé served as speaker of the House of Commons from 1980 to 1984. She was Canada's first woman speaker.



Jeanne Sauvé

Savage is a river in mountainous northwestern Tasmania, Australia. It is the location of a large-scale iron ore mine. Low-grade iron ore called *magnetite* is taken from an open-cut mine near the river. The magnetite is crushed to a fine powder, from which the iron particles are extracted magnetically. Water is added, and the resulting slurry is pumped 87 kilometres by pipeline to Port Latta. There, the iron ore is formed into pellets, about a centimetre in diameter, which are hardened by heating. About 2,286,000 metric tons of pellets are loaded each year into bulk carriers for export to Japan. **Savanna**, also spelled *savannah*, is a grassland with widely scattered trees and shrubs. Most savannas are in the tropics and lie between deserts and rainforests. Certain grasslands in temperate areas are also sometimes called savannas. This article discusses tropical savannas. For information about other savannas, see **Forest** (Savannas).

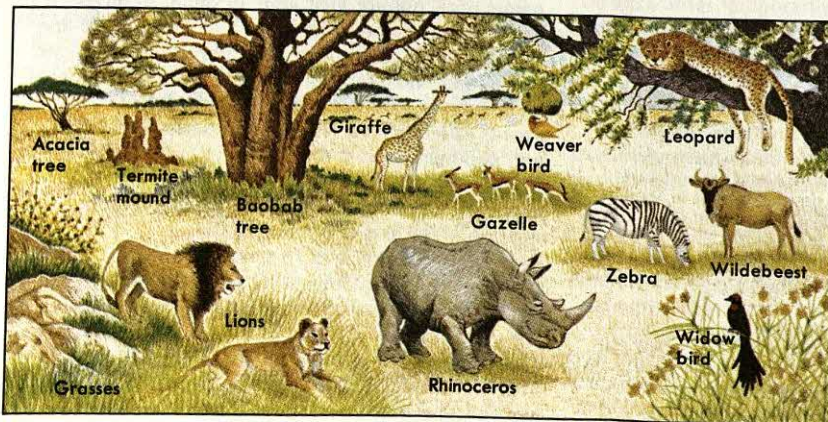
Savannas cover more than two-fifths of Africa and large areas of Australia, India, and South America. They occur in regions that have both rainy and dry seasons.

Most savannas receive from 76 to 100 centimetres of rain annually. But some get as little as 25 centimetres and others have as much as 150 centimetres. Grasses on the driest savannas grow several centimetres high. On more humid savannas, grasses grow over 2 metres tall, and trees are more abundant. Grasses on the wettest savannas may reach heights of 3 metres or more.

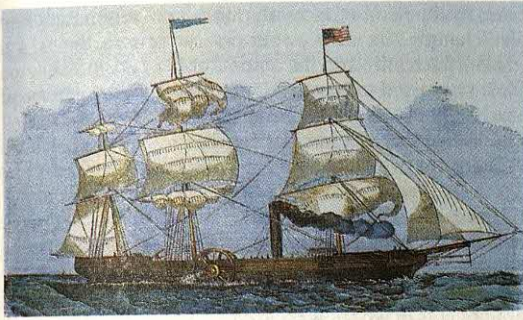
Most savanna grasses grow in clumps and do not form a continuous cover. Other nonwoody plants, including members of the daisy (composite) and pea (legume) families, grow among the grasses. Acacias, baobabs, and palms are some common savanna trees.

The growth of trees on savannas is limited by the dry season, which may last up to five months. When the dry season begins, grasses stop growing and turn brown, and most trees shed their leaves. Only trees with great resistance to drought can survive. During the dry season, frequent brush fires destroy many young trees. Grasses have extensive root systems that survive the fires and send up fresh shoots as soon as the rains return. On some savannas, poor drainage and other soil conditions also favour the growth of grasses instead of trees.

A wide variety of animals live on savannas. Large herds of antelope and zebras graze on the African sa-



A wide variety of animals live on savannas. Lush grasses provide abundant food for many species of grazing animals, such as gazelles and zebras. Giraffes eat leaves, twigs, and fruit from widely scattered trees. Such meat eaters as lions and leopards prey on the grazing animals. Many kinds of birds, insects, and other small animals also inhabit savannas.



The *Savannah* used both steam and sails for power.

vannas. Cheetahs, hyenas, lions, and other meat eaters prey on these animals. Many species of rodents, birds, reptiles, and insects also inhabit savannas.

See also **Africa** (Deserts, grasslands, and forests); **Forest** (map: Forests of the world; picture); **Grassland**.

Savannah, nuclear ship. See **Ship** (Nuclear power and automation; picture).

Savannah was the first steamship to cross the Atlantic Ocean. The *Savannah* sailed from Savannah, Georgia, U.S.A., on May 22, 1819, and docked in Liverpool, England, on June 20, 1819. It was driven by steam for between 80 and 105 hours. Sails were used the rest of the time. See also **Ship** (Oceangoing steamships).

Savannah, Georgia (pop. 137,560; met. area pop. 242,622), is one of the chief United States Southern ports. It has one of the world's most up-to-date systems of docks and warehouses. Savannah lies about 29 kilometres inland from the Atlantic Ocean, across the Savannah River from South Carolina. A channel 12 metres deep connects it with the Atlantic Ocean.

Hunter Army Airfield near Savannah and Fort Stewart 64 kilometres south of the city make up the United States Army 24th Infantry Training Center for helicopter pilots. Armstrong State College, Savannah College of Art and Design, and Savannah State College are in Savannah. The Telfair Academy of Arts and Sciences is one of the leading art galleries in the Southeastern States. The Bethesda Home for Boys, the oldest children's home in the United States, opened on its present site near Savannah in 1740. Many people visit the home of Juliette Gordon Low, who founded the Girl Guides in the United States.

Savannah is the trading centre for a large farming region. Nearby sawmills ship much timber through Savannah each year. The city's chief industry is the manufacture of *kraft*, a strong paper used for making bags. Mills make kraft from southern slash pine, which grows around the city. Savannah is an important naval stores centre. Other products include wood pulp, refined sugar, packaged tea, petroleum products, construction materials, jet aircraft, and truck trailers.

James Oglethorpe founded Savannah on Feb. 12, 1733, as Georgia's first colonial settlement. Because of this, people call it the *Mother City of Georgia*. Savannah was one of the first planned cities in the United States. Settlers built it according to a design by William Bull and Oglethorpe. It was the chief city and capital of the

Georgia colony until after the American Revolution ended in 1783. Eli Whitney's cotton gin, which led to a great expansion of cotton farming, was invented near Savannah in 1793. The first steamship to cross an ocean, the S.S. *Savannah*, travelled from Savannah to Liverpool, England, in 1819. In 1864, during the Civil War, General William T. Sherman ended his march to the sea when he captured Savannah.

In 1955, residents created the Historic Savannah Foundation and began a project to restore old buildings in the city's original section. More than 1,000 houses have been restored, and the area has become a popular tourist attraction. Savannah is the seat of Chatham County and has a council-manager form of government.

Save the Children is an independent, nonprofit organization that works to help needy children by improving the communities where they live. It sponsors programmes in 42 countries. Save the Children projects include nutrition and health programmes, and the construction of homes, roads, schools, and water systems. The organization was founded in 1932. Headquarters are in Connecticut, U.S.A.

Savernake Forest is a large woodland tract in the eastern part of Wiltshire, England. It covers about 1,600 hectares. The forest was once part of a royal estate. Savernake is also the name of two parishes, North Savernake and South Savernake. The parishes stand about 10 kilometres southeast of Marlborough. See also **Wiltshire**.

Savings bank is a common type of savings institution. Nearly all savings banks are *mutual savings banks*, which are run by a board of directors. Their mutual status means that all net profits are redistributed among the depositors. Depositors are creditors of the bank and have no voting powers.

Savings banks offer two main kinds of savings plans — *passbook accounts* and *time deposits*. With a passbook account, the depositor can withdraw money without giving advance notice to the bank. For withdrawal of time deposits, the bank may require prior notification.

To protect depositors' money, governments usually strictly regulate the investments savings banks can make. The banks invest primarily government equities in long-term mortgages. Other investments include corporate bonds and consumer loans.

The first savings banks were established during the late 1700's. They were created as charitable institutions to promote thrift among the poor and working classes.

Savonarola, Girolamo (1452-1498), was an Italian friar, a fiery religious reformer, and a preacher. By 1490, he had begun his attempts to reform the city of Florence through preaching. He was a highly emotional, but effective, preacher. His humour, charm, colourful language, and theatrical manner made him a leading figure. He claimed powers of prophecy, and criticized the immorality of Pope Alexander VI (see **Alexander VI**). He predicted punishment of the Roman Catholic Church and Italy.

Pope Alexander VI ordered Savonarola to Rome in 1495 to explain his claim to special revelation, but the friar refused. He said his health and fear of violence on the way made it impossible and stated: "It is not the will of God that I leave Florence." The pope then ordered him to stop preaching.

When Savonarola resumed preaching during Lent in 1496, the pope excommunicated him for disobedience. When he continued his defiance, Alexander VI threatened to place Florence under an *interdict* (ban on worship) unless the city could force him to go to Rome or could force him to be silent until he asked for absolution. Savonarola surrendered to the civil authorities. He was tried and condemned by an ecclesiastical court, which turned him over to the civil authorities for punishment. Savonarola was hanged and his body burned.

Savonarola was born in Ferrara of a noble family. He studied humanism, philosophy, and medicine before he joined the Dominican order in 1474. The English novelist George Eliot portrayed Savonarola's life in her novel *Romola*.

Savoy was, until 1946, the oldest reigning family in Europe. Humbert, count of Savoy, founded the house during the 1000's. The family originally ruled a few small countries on the slopes of the Alps in northwestern Italy. Then it acquired holdings on the plains below the mountains. Genoa was added in 1815. The family extended its rule over all Italy by taking advantage of three wars fought between 1859 and 1871. The House of Savoy lost the Italian throne in 1946. See also **Victor Emmanuel**.

Saw is a cutting tool that has a metal blade with sharply pointed teeth along one edge. Saws are used to cut wood and almost any other material, including plastics and steel.

The teeth of a saw slant alternately to the left and right. This system of slanting, called *saw set*, helps the saw move through the material being cut. As a saw cuts, the teeth remove some of the material as sawdust and form a channel wider than the blade. The blade can slide through this channel, called a *kerf*, without getting stuck.

The size of a saw's teeth determines the smoothness of the material where it has been cut. This size is indi-

cated by the number of tooth points per centimetre of blade length. The more points per centimetre, the smaller the teeth—and the smoother the cut surface. Most saws used for cutting timber into smaller pieces have 2 to 4 points per centimetre. For fine work, saws with as many as 8 points per centimetre may be used.

There are two main kinds of saws: (1) handsaws and (2) power saws.

Handsaws are alternately pulled and pushed with a back-and-forth motion. Some make only straight cuts, and others make both straight and curved cuts.

Several varieties of handsaws may be used for straight cuts in wood. A *crosscut saw* cuts across the grain of a board. A *ripsaw* cuts lengthwise with the grain. A *backsaw* or *tenon saw* moves both across and with the grain. Craftworkers often use a backsaw along with a tool called a *mitre box*, which guides the blade for accurate cuts.

To cut curves in thin boards, craftworkers may use a *coping saw*. This saw has a thin, flexible blade fastened at each end across a U-shaped frame. *Keyhole saws* and *compass saws* cut curves in thick boards. They have a narrow, rigid blade with a handle on one end.

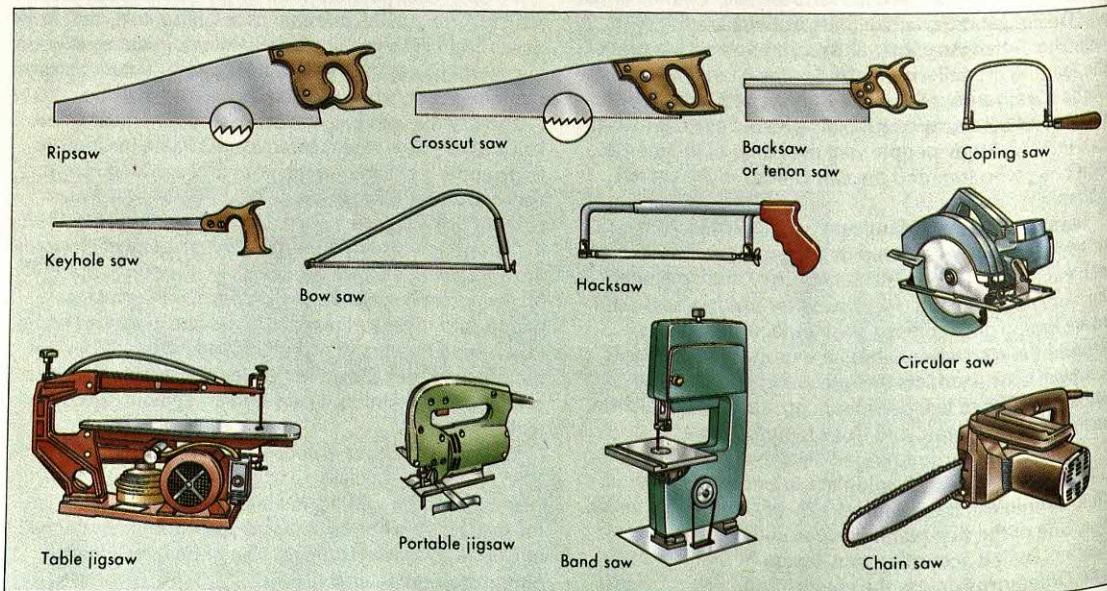
Straight or curved cuts in metal are made with a *hack-saw*. Various replaceable blades of hardened steel cut different kinds and sizes of metal objects.

Power saws are driven by an electric motor or a petrol engine. Some are mounted on a special table, and others are held by hand. Most kinds of power saws can be fitted with various types of blades to cut different materials. The blades of power saws move at great speed, and so these saws should be handled with care.

The most widely used type of power saw is the *circular saw*. Its dislike blade makes straight, accurate cuts. Circular saws may be table-mounted or hand-held.

To make straight or curved cuts, craftworkers use a table-mounted or hand-held *jigsaw*. This saw has a thin blade that moves up and down at high speed. A hand-

Kinds of saws

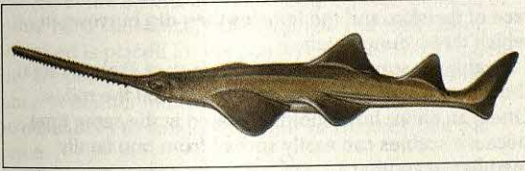


held *jigsaw* also uses this type of motion. The *band saw* is a table-mounted power saw used for straight or curved cuts. This saw's blade is an endless flexible steel band that runs between two large pulleys.

A hand-held power saw called a *chain saw* is used to cut trees and heavy timber. The saw's teeth are attached to an endless moving chain.

See also **Timber** (pictures); **Woodworking**.

Sawfish is a fish that lives in the warm parts of the oceans and in some freshwater coastal areas. It is a kind of ray. The sawfish can be recognized by its long, flat snout that looks like a saw. The saw shark has a similar snout, but can be told from the sawfish by the position of the gill openings. In the saw shark, these slits are on the side of the head. In the sawfish, the slits are on the undersurface. The snout may be 1.2 metres long, and the fish itself may exceed 10 metres including the snout.



The **sawfish**, a type of ray, has a sharklike body and a long snout. The snout has a row of teeth on each edge, like a saw.

Each side of the snout has many sharp teeth like the teeth of a saw. The sawfish feeds on other fish and small *invertebrates* (animals without backbones). It uses its snout to disable swimming prey or to dislodge mud-dwelling prey. There are several species of sawfish. The *greater sawfish* is found in all tropical oceans.

Scientific classification. The sawfish belongs to the sawfish family, *Pristidae*. The greater sawfish is *Pristis pectinata*.

Sawfly is an insect related to ants, bees, and wasps. Sawflies lay their eggs in the leaves and stems of plants and trunks of trees. Adult females have a sawlike organ that slits the plant tissue and pushes the egg inside.

Most immature sawflies resemble caterpillars but have more legs along their abdomens. Some sawfly caterpillars gather in large numbers and may form *galls* (swellings) on plants. Adult sawflies have four membranous wings.

The most destructive sawflies are those that attack *coniferous* (cone bearing) trees. Other species damage garden roses, currant bushes, wheat stems, cherry and pear trees, and birch and elm trees.

Scientific classification. Sawflies belong to the order Hymenoptera. They are classified in several families, including *Diprionidae* and *Tenthredinidae*.



Sawfly

Sawmill. See **Timber**.

Sawyer, Tom. See **Twain, Mark**.

Saxe-Coburg, House of. See **Kings and queens of Britain and Ireland** (The Houses of Saxe-Coburg and Windsor); **Royal Family of the United Kingdom**.

Saxifrage is any one of a group of small, hardy plants that grow in cold and temperate parts of the Northern Hemisphere. The plants were given the name *saxifrage*, which means *rock-breaker*, because they usually grow on or between rocks.

Saxifrages grow from 5 to 90 centimetres high. The thick, fleshy leaves grow near the ground. The flower stalk grows straight upward, and bears clusters of white, pink, purple, or yellow blossoms. The blossoms usually have 5 sepals, 5 petals, and 10 stamens.

The *meadow saxifrage* is a common European species. It has white flowers, and blooms in the spring.

Scientific classification. Saxifrages are in the saxifrage family, *Saxifragaceae*. They make up the genus *Saxifraga*. Meadow saxifrage is *S. granulata*.



Saxifrage

See also **Currant**; **Deutzia**; **Gooseberry**; **Hydrangea**; **Mock orange**.

Saxons were members of a Germanic people that invaded the island of Britain about 1,500 years ago. The Angles and the Jutes, who were also Germanic peoples, invaded Britain at about the same time. These groups mixed and eventually established the Anglo-Saxon kingdom, which lasted until the Norman Conquest of 1066 (see **Norman Conquest**).

The ancient geographer Ptolemy first mentioned the Saxons in a book he wrote during the A.D. 100's. According to Ptolemy, the Saxons lived in what is now the state of Schleswig-Holstein in Germany. They were a warlike people who invaded Roman territory in the late 300's, during the reigns of the emperors Julian and Valentinian. By the 500's, the Saxons had settled in most of what is now northern Germany, between the Elbe and Rhine rivers. During the 400's and 500's, the Saxons invaded Britain, conquered the Celts who lived there, and settled in southern and eastern Britain.

In the 700's, Charlemagne conquered the Saxons still on the continent, after about 30 years of war. He forced them to accept Christianity, and made their land, then called *Saxony*, part of his empire.

See also **Anglo-Saxons**; **England** (History).

Saxony, a state in east-central Germany, covers an area of 18,300 square kilometres.

In the 1400's, the eastern part of the Duchy of Saxony came under the rule of the Wettin family, who called it Saxony. Saxony joined the German Empire in 1871. It became a republic after World War I (1914-1918). From 1919 until 1945 it was a German state. The Soviet Union occupied Saxony after Germany surrendered in World War II (1939-1945). From 1949 until 1952 it was a state in the former German Democratic Republic. Saxony was abolished as a political unit in 1952, and divided into the districts of Leipzig, Dresden, and Chemnitz (named Karl-Marx-Stadt during the period 1953-1990). Following the reunification of Germany in October 1990, Saxony was reconstituted as a German state.

See also **Dresden**; **Seven Weeks' War**.

Saxophone is a woodwind musical instrument made of brass. It consists of a tube with a mouthpiece at one end and a bell-shaped opening at the other end. The saxophone has holes covered by small levers called *keys*.

To play the instrument, the musician blows on a flat cane reed attached to the mouthpiece and fingers the keys to open and close the holes. The most popular saxophones, from highest to lowest range of pitch, are soprano, alto, tenor, and baritone.

Adolphe Sax, a Belgian instrument maker, invented the saxophone about 1840. The instrument is popular in concert bands, dance bands, and jazz groups. It is occasionally played in orchestras.



The saxophone is a woodwind instrument made of brass. A musician plays different notes by blowing through the mouthpiece and pressing keys that open and close the finger-hole sockets.

Sayers, Dorothy (1893-1957), an English author, was one of the most famous writers of detective stories of the 1900's. Her best-known works feature the adventures of Lord Peter Wimsey, a sophisticated, scholarly amateur detective.

Sayers, the daughter of an Anglican minister, was born in Oxford and graduated from Oxford University. Her Wimsey stories, which reflect her background, involve well-bred characters who have graceful manners.

The most popular of the 11 Wimsey novels include *Whose Body?* (1923), Sayers' first book; *Strong Poison* (1930); *Murder Must Advertise* (1933); *The Nine Tailors* (1934); and *Gaudy Night* (1935).

In 1937, Sayers abandoned detective fiction and turned to religious works. The first of these was a play, *The Zeal of Thy House* (1937). In *Mind of the Maker*

(1941), she compared God and people as creative beings. From 1949 until her death, Sayers worked on translations of Dante's *Divine Comedy*.

Scab, a disease of plants. See **Apple** (Pests and diseases); **Potato** (Diseases).

Scab, in medicine. See **Blood** (Blood clotting).

Scabies is a contagious skin disease that causes intense itching. In adults and older children, scabies may affect any part of the body from the neck down. It most frequently involves the skin between the fingers; under the arms; and on the wrists, elbows, breasts, penis, and lower back. Babies may be infected over their entire body, including the head.

Scabies is caused by the *itch mite*, a spiderlike animal known scientifically as *Sarcoptes scabiei*. This mite can barely be seen with the unaided eye. The female burrows under the skin and lays her eggs there. The eggs hatch three to five days later. The young mites mature into adult form in five to 14 days. They mate on the surface of the skin, and the females then dig burrows in which their young hatch.

Scabies is spread through skin contact. Doctors treat the disease with creams or lotions that kill the mites. Often, an entire household is treated at the same time because scabies can easily spread from one family member to another.

Scafell Pike is the highest mountain in England. It rises 978 metres above sea level in the Lake District. Scafell Pike is part of the Cumbrian Mountain group and is located in southern Cumbria, east of Wastwater. The summit of Scafell Pike belongs to the National Trust.

See also **Cumbria**; **Lake District**.

Scalawags were whites from the American South who worked with blacks and northern Republicans to control politics in the South after the American Civil War. Southern Democrats, who believed these people were "beasts in men's clothing," called them *scalawags*, a term commonly applied to useless cattle. Many scalawags were business owners and planters who had opposed *secession* (withdrawal) from the Union before the war. Many other scalawags were poor farmers from the hilly regions of the South. Some scalawags sought personal gain, but others believed the South had to discard its prewar social and racial views to survive. Scalawags helped to bring about educational and social reforms and to pass laws that allowed blacks to vote. They gradually disappeared during the 1870's, as Democrats regained control of the South.

Scalds. See **Burns** and **scalds**.

Scale. Scales are flat plates that form the outer covering of most fish and of many snakes and lizards. Hardened, horny folds of skin form the scales of reptiles. In most fish, the scales are bony discs developed from the under skin. But sharks' scales bear enamel on the outer surface and bone on the inner surface. Scales also cover a few mammals, such as the scaly anteater. Scales overlap one another like roofing slates, and form a protective armour for the softer body beneath. They vary in size, shape, and arrangement, depending on the animal. The wings of butterflies and moths have tiny, downy scales.

In botany, scales are little flaky leaves that cover tree buds and woody plants in cold and temperate climates. These scales shield the buds from sudden temperature

changes. The regular pieces of a pine cone are called scales.

See also **Scale insect**; **Fish** (Scales; illustrations).

Scale. See **Interior decoration** (Scale); **Map** (Scale); **Railway, Model** (Scale and size).

Scale, in music. See **Music** (Notes).

Scale, Weighing, is a device used to measure weight or mass. Scales are used in business and science to weigh loads ranging from extremely light substances, such as drugs, to railway wagons that weigh many tons. There are three main types of weighing scales. In order of their historical development, they are (1) balances, (2) mechanical scales, and (3) electronic scales.

Balances, the oldest type of scale, were first used in ancient Egypt about 2500 B.C. The two main kinds of balances are the *equal-arm balance* and the *steelyard*.

The *equal-arm balance* consists of a horizontal bar with a pan suspended from each end. The bar is supported at the centre by a knife-edged piece of metal or other hard substance, called a *pivot*. The load being weighed is placed in one pan. Weights of known quantity are placed in the other pan until the two pans balance. A pointer indicates balanced pans. Scientists can use balances to weigh very light substances. See **Balance**.

The *steelyard* was developed by the ancient Romans about 2,000 years ago. This kind of scale uses a small weight to balance a large load. The horizontal bar on a steelyard has arms of unequal length. A pan or hook on the shorter arm holds the load being weighed. A small weight called a *poise* is moved along the longer arm until it balances the load. Markings on this arm indicate the load's weight.

Mechanical scales were first developed in the 1700s. Nearly all mechanical scales have levers that reduce the force of a large load to a smaller force that is read by a sensitive weight indicator. Mechanical scales may be grouped according to the type of weight indicator used. There are three types of mechanical indicators: (1) a beam, (2) a spring, and (3) a pendulum.

Beam scales use a poise to indicate the weight of the load. The poise is moved along the beam until the load

is balanced. Markings on the beam give the weight. Many doctors use beam scales to weigh patients.

Spring scales use one or more springs to balance the load, which rests on a pan or platform. The weight of the load stretches or compresses each spring. This action causes the weight indicator to move and point to the weight. A bathroom scale is a type of spring scale. Hanging spring scales operate without levers.

Pendulum dial scales use a dial containing a weighted pendulum to indicate the weight. The pendulum swings out to one side to balance the platform containing the load. A needle hooked to the pendulum rotates on the dial to give the weight. This mechanism is used in many types of scales throughout industry. Food stores use these scales to weigh meat and produce.

Electronic scales use various electronic methods to measure and indicate weight. Most electronic scales contain a device called a *strain-gauge load cell*. This device measures the force created by the weight of the load placed on the scale. It then converts the force measurement into an electrical signal and transmits the signal to an electronic weight indicator. The weight indicator converts the signal into a weight reading.

Most electronic scales contain *microprocessors* (tiny computer chips) that enable the scales to perform activities in addition to weight measurement. Such activities may include determining the number of items in the load, calculating the price of the load, and transmitting information to printers and computers.

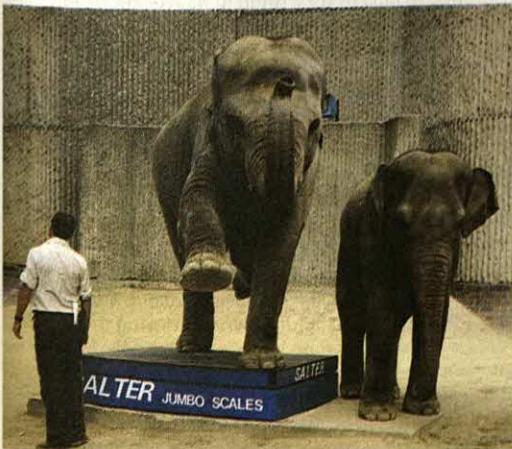
Scale insect is one of many kinds of sucking insects that feed on plants. Scale insects cluster on plants, sucking out the juices through their tiny, tubelike beaks.

The female scale insect does most of the damage. The adult male lives long enough only to fertilize the female's eggs. Most kinds of female scale insects are oval-shaped. They measure from 1 millimetre to 2.5 centimetres long, depending on the species. The scale insect gets its name from the waxy or scaly shell that usually covers its body. Some kinds of female scale insects hardly look like insects at all. They lack eyes, feelers, and legs and rarely move.

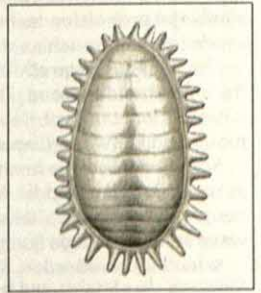
Scientists know of more than 2,000 kinds of scale insects. The *San Jose scale*, one of the best-known and most harmful kinds, feeds on many types of fruit trees and shrubs. It was first found in the United States near San Jose, California, in about 1870. Another scale insect that attacks fruit trees, the *cottony cushion scale*, seemed likely at one time to wipe out all the citrus trees in California.

Some scale insects are useful. Shellac, a varnish, comes from a scale called the *lac insect* (see **Lac**). Cochineal, a dye, comes from the *cochineal scale*. One kind of scale insect is used as jewellery. This insect covers itself with shells called *ground pearls*.

Scientific classification. Scale insects are members of the order Hemiptera.



An electronic scale transmits signals from a weighing platform to a remote weight indicator.



Scale insect

Scallop is a shellfish that is used for food. It is a *bivalve mollusc* (animal with a two-pieced shell around its soft, boneless body). Scallops live in shallow waters in almost all seas and often are found in large groups on sand or fine gravel.

The scallop shell is made up of two equal rounded valves that often have fanlike, radiating ribs. At the hinge of the shell, where the ligament unites the two valves, there are two winglike projections called *ears*. The inside of the shell is lined with fleshy skin called the *mantle*. The edge of the mantle is folded and fringed with numerous *tentacles* (feelers). A row of brightly coloured eyes lies at the base of the tentacles.

Scallops are unusual in that they can "swim" through the water in a series of jerky movements by forcing water between the valves of the shell. This behaviour is best shown by some of the smaller scallops such as the *queen scallop* of the Atlantic and Mediterranean. Scal-

Location of Scandinavia



lloping Scandinavian countries. Southern Sweden is called *Skåne*, or *Scania*.

See also **Denmark; Norway; Sweden**.

Scandinavian literature consists of the literature of the Scandinavian countries—Denmark, Norway, and Sweden—and of Finland and Iceland.

Early Scandinavian literature developed from oral tales and poems passed down from generation to generation for several hundred years. Some poems about the lives of the upper classes in the *Viking Age* might date from the A.D. 800's (see **Viking**).

During the 1200's, oral ballads became popular, especially in Denmark and Sweden. The ballads praised the deeds of heroes, told tragic stories, and described encounters between human beings and magical creatures.

Between 1100 and 1300, lengthy stories called *sagas* were written. Sagas tell of heroic adventures and the lives of chieftains. *Njal's Saga*, by an unknown author, resembles a historical novel. It describes a violent feud between two families. Icelander Snorri Sturluson's *The Heimskringla* (early 1200's), relates the history of the Norwegian kings who reigned before the 1200's.

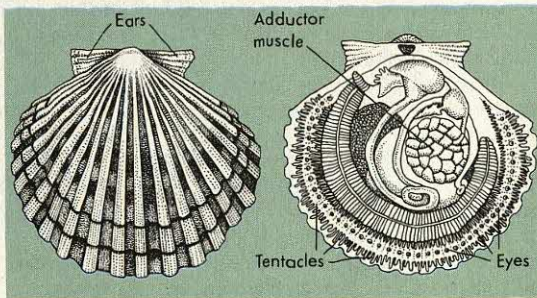
During the Reformation, the Bible was translated into Swedish and Danish. Latin previously had been the language of learned authors. But in the 1500's, churches encouraged hymns to be written in native languages. Hymns written by the Dane Thomas Kingo and the Norwegian Petter Dass in the 1600's are still used.

The 1700's. During the 1700's, writers became more secular and more interested in the everyday life of common people. For example, the Swedish poet Carl Michael Bellman wrote about rowdy life in the taverns of Stockholm, Sweden.

Scandinavian theatre also grew in importance during the 1700's. Ludvig Holberg, Scandinavia's first major playwright, became famous for his witty comedies. Johannes Ewald, a Dane, won praise for his tragedies.

The Golden Age. Scandinavia, Finland, and Iceland produced many outstanding writers during the 1800's. Most writers of this time were influenced by two literary movements—*romanticism* in the early and mid-1800's, and *realism* in the latter third of the century. See **Romanticism; Realism**.

Many romantic writers emphasized imagination, emotion, and the glory of the Viking Age. These writers included Henrik Arnold Wergeland of Norway, Carl



A scallop has a hard shell, *left*. Tentacles and a row of eyes grow along the inside edge of the shell, *right*.

lops can also move fast along the sea bed employing a similar jet propulsion technique which they use to evade predators such as starfish.

The scallop's large adductor muscle is the only part of the animal sold for food. The tender meat tastes somewhat like lobster meat. Baked scallop with cheese is a famous dish known as *Coquilles St. Jacques*.

Scallop shells have been used widely in designs and as utensils. In the Middle Ages (A.D. 400's to the 1500's), people wore scallop shells on their hats to show they were on a *pilgrimage* (journey to a holy place).

Scientific classification. Scallops belong to the phylum Mollusca, class Bivalvia, and family Pectinidae. The queen scallop is *Chlamys opercularis*.

See also **Shell** (picture).

Scalpel. See **Surgery** (Instruments); **Knife**.

Scandinavia is the name often given to the peninsula of Norway and Sweden. But the term Scandinavia really refers to the countries where Scandinavian people live. This includes Denmark, Norway, and Sweden. These countries and Finland and Iceland form *Norden*. The countries of Norden are often mistakenly referred to as Scandinavia.

Fennoscandia is a term that is often used to describe Finland and the Scandinavian Peninsula. Many regions near the Baltic Sea are known as *Baltoscandia*, because their climate and customs are much like those of the

Jonas Love Almquist of Sweden, and Nicolai Frederik Severin Grundtvig of Denmark. Many romantics were interested in folklore. Elias Lönnrot of Finland used his country's ancient myths and legends to form the epic poem *The Kalevala* (1835). Peter Christen Asbjørnsen and Jørgen Moe, both of Norway, published Norwegian folk tales. Hans Christian Andersen of Denmark wrote fairy tales and stories that became world famous.

Realistic writers tried to describe life accurately and objectively and were often critical of society. The works of the Norwegian Henrik Ibsen and the Swede August Strindberg greatly influenced modern Western drama. In such plays as *A Doll House* (1879) and *An Enemy of the People* (1882), Ibsen attacked the double standard of people, particularly where marriage is concerned. Strindberg also attacked social customs. In his later plays he helped develop the literary movement *expressionism* (see *Expressionism* [Expressionist drama]).

The modern period in Scandinavian literature began in the 1890's and included both realistic and romantic writings. The Norwegian Knut Hamsun wrote about people who rejected society in the novels *Hunger* (1890) and *Pan* (1894). The Dane Martin Andersen Nexø's monumental epic *Pelle the Conqueror* (1906-1910) praises the early labour movement. Selma Lagerlöf of Sweden and Sigrid Undset of Norway revived the historical novel. Lagerlöf's *Gösta Berling's Saga* (1891) relates the colourful adventures of a boastful young man and his companions. Isak Dinesen of Denmark wrote about her years in Kenya in *Out of Africa* (1937). She composed complex, mysterious tales in such collections as *Seven Gothic Tales* (1934) and *Winter's Tales* (1942). A poor Icelandic fishing community is the subject of *Salka Valka* (1931-1932) by Halldór K. Laxness of Iceland. In the play *The Hangman* (1933) and the novel *The Dwarf* (1944), Pär Fabian Lagerkvist of Sweden describes the cruelty he saw in life.

Since the end of World War II in 1945, writers who have dealt with feminist issues have become prominent. Among them are Sweden's Sara Lidman, Denmark's Dea Trier Mørch, Finland's Märta Tikkanen, Iceland's Svava Jacobsdóttir, and Norway's Herbjørg Wassmo.

Related articles. See the *Arts* section of the *Denmark*; *Norway*; and *Sweden* articles. See also the following articles: Andersen, Hans Christian; Asbjørnsen, Peter Christen; Bjørnson, Bjørnstjerne; Dinesen, Isak; Edda; Hamsun, Knut; Holberg, Ludvig; Ibsen, Henrik

Kierkegaard, Søren Aabye
Lagerkvist, Pär Fabian
Lagerlöf, Selma
Mythology (Teutonic mythology)
Saga

Skald
Snorri Sturluson
Strindberg, August
Topelius, Zachris
Undset, Sigrid
Wergeland, Henrik Arnold

Scandium is a soft, silvery-white metal. Its chemical symbol is Sc. It has an atomic number of 21 and an atomic weight of 44.9559. In 1869, Dmitri Mendeleev of Russia predicted its existence. In 1879, Lars Nilson of Sweden discovered it in the minerals gadolinite and euxenite. *Scandium* is named after Scandinavia.

Scandium is found in tiny amounts in over 800 minerals but is costly to extract and has no significant use. Scandium melts at 1541 °C and boils at 2831 °C. It has a density of 2.989 grams per cubic centimetre at 20 °C.

See also *Element*, *Chemical* (table).

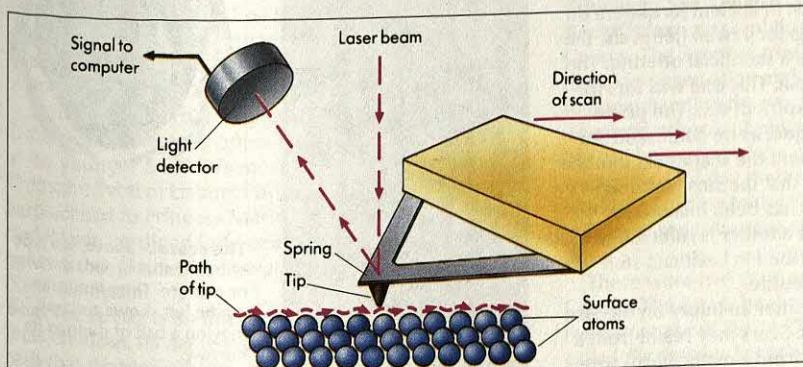
Scanning probe microscope is any of a type of microscope that scans the surface of materials with a sharp point and display the results on a televisionlike screen. The point, called a *probe*, can be as tiny as 0.3 billionth of a metre across—about the width of an atom. Scanning probe microscopes can provide three-dimensional images of individual atoms. They have become important research tools in physics, engineering, and chemistry.

The first of these microscopes was the *scanning tunnelling microscope (STM)*, invented in 1981 by physicists Gerd Binnig of West Germany and Heinrich Rohrer of Switzerland. Binnig and Rohrer won shares of the 1986 Nobel Prize in physics for their invention.

The STM creates an atomic map of surfaces. It works with materials that can carry an electric current. The STM brings its probe to within 1 *nanometre* (1 billionth of a metre) of the *sample* (the surface being studied) and creates a *voltage* (difference in charge) between the probe and the sample. The voltage creates a *tunnelling current*, an electric current consisting of a flow of electrons between the probe and the sample.

The strength of the tunnelling current depends on the distance between the probe and the sample. As the probe scans the sample, the STM measures the current and keeps it constant by raising or lowering the probe. A computer records the probe's movements and uses them to create the image. The image can be up to about 100 million times as large as the sample.

Another major type of scanning probe microscope is the *atomic force microscope (AFM)*. The AFM does not use a tunnelling current, so researchers can use it to



An atomic force microscope, a type of scanning probe microscope, uses a spring-mounted probe to scan surface atoms of an object. As the top of the probe moves up and down, a laser beam reflected from the spring strikes a light detector. The pattern of the reflected light provides information that a computer uses to create an image.

Scapa Flow is a natural harbour surrounded by the Orkney Islands off the northern part of the Scottish mainland. Scapa Flow is an important harbour for North Sea Oil.



study samples that do not conduct electricity. In most applications, the probe gently touches the sample. As the probe scans the sample, the AFM measures the mechanical force between the probe and the sample. When the force increases due to a bump on the sample, the AFM moves the probe upward. When the force decreases due to an indentation in the sample, the AFM moves the probe downward. A laser device measures the up-and-down movements. A computer uses the measurements to create the image.

Another type of AFM has a magnetic probe. The probe does not touch the sample but moves up and down in reaction to magnetic forces between itself and the sample. Researchers use this AFM with such samples as the surfaces of magnetic disks for computers.

Other scanning probe microscopes include the *scanning thermal profiler*, which reacts to temperature differences on the sample. The *scanning near field optical microscope* measures light reflected from the sample. The *scanning electrochemical microscope* reacts to chemical changes on the sample.

Scapa Flow is a sea basin surrounded by the Orkney Islands off northern Scotland. It is about 24 kilometres long and 13 kilometres wide. Scapa Flow became the headquarters of the battleship squadrons of the British Grand Fleet during World War I. On June 21, 1919, the defeated German navy scuttled its remaining ships in the basin. In World War II, a German submarine sank the British battleship *Royal Oak* as it lay at anchor in Scapa Flow. During the 1970's and 1980's, Scapa Flow developed into an important terminal for an oil pipeline from the North Sea.

See also **Orkney**.

Scapegoat originally meant one of the two goats received by the Jewish high priest in ancient Jerusalem on the Day of Atonement. One was for *Yaweh* (Jehovah), the Hebrew God, and was killed as a sacrificial offering. The second was called the scapegoat. This one was for *Aza-zel*, which may have been the spirit of evil. The priest laid his hands upon the scapegoat as he confessed the people's sins. Then the priest sent the scapegoat into the wilderness. This was a symbol that the sins had been forgiven. Today, a person who has been blamed for something which is the fault of another is referred to as a scapegoat. The ritual is described in Leviticus 16.

Scapula, in anatomy. See **Shoulder**.

Scar is a permanent mark left after an injury on the skin or other part of the body heals. Scars may result from a wound, such as a deep cut, or from a major burn, sore,

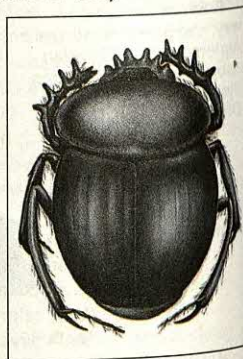
or surgery. Generally, such injuries damage the *dermis* (second layer of skin), which contains connective tissue. Damage to only the *epidermis* (outermost layer of skin), such as a scratch, does not produce a scar.

When an injury heals, new connective tissue forms. Then a new epidermis covers the injured area—the scar. The scar at first is red. The redness in time fades, but the scar may remain white and hairless. The cells that contribute to skin colour and hair formation die when the injury occurs. As they heal, scars often itch or hurt.

Scars vary according to the area where they form. For example, a cut over the breastbone produces a wider, thicker scar than a similar cut on the face. Sometimes, too much connective tissue forms during healing. This condition results in an elevated scar. The excessive growth may also produce a *keloid*, a large scar that extends beyond the damaged area. Ugly scars may be corrected surgically.

Scarab is the name of a large group of beetles. There are about 20,000 species of scarabs. Some species feed on plants and in some countries may be harmful to lawns or crops. Other species breed in *dung* (manure). They sometimes roll this dung into small pellets, which they roll to their underground burrows to be used as larval food. Eggs are laid in the pellets.

The ancient Egyptians regarded the pellets of the *sacred scarab* as symbols of the world. They believed that



The scarab, above, is a type of beetle that breeds in *dung*, or manure. The photograph on the left shows a scarab moving a ball of dung to its burrow.

projections on the heads of the beetles were emblems of the rays of the sun. For the Egyptians, the sacred scarab also symbolized the resurrection and immortality. They carved figures of the insects out of stone or metal, and used them as charms. Such figures were called scarabs. Usually, Egyptians removed the heart of a dead person, and put a large carved and often jewelled scarab in its place when the body was embalmed.

Scientific classification. Scarabs belong to the order Coleoptera and make up the scarab family, Scarabaeidae. The sacred scarab is *Scarabaeus sacer*.

See also **Beetle** (Scarabs); **Japanese beetle**; **June beetle**.

Scarborough (pop. 107,800), a local government district in North Yorkshire, England, includes the harbour and resort towns of Scarborough and Whitby. It also includes part of the North York Moors National Park.

The district's largest town is Scarborough, which stands on cliffs overlooking North Bay and South Bay. The bays are separated by the headland of Castle Hill. Interesting buildings include King Richard III House and Wood End. St. Mary's Church, built in the Early English style, has the grave of Anne Brontë (see **Brontë sisters**). Many important conferences are held in the town.

See also **Yorkshire**.

Scarlatti, Alessandro (1660-1725), was an Italian composer known primarily for his operas. Scarlatti spent most of his life in Naples and often is referred to as the founder of the Neapolitan school of opera which flourished in the 1700's.

Scarlatti composed about 85 operas. Most of these are in the *opera seria* (serious opera) style. For more information about this style, see **Opera** (Baroque opera [Opera seria and opera buffa]). Scarlatti's most popular operas during his lifetime include *Il Mitridate Eupatore* (1707) and *Il Tigrane* (1715). Scarlatti also composed more than 600 cantatas, as well as oratorios, church music, and some instrumental music.

Scarlatti was born in Palermo. At the age of 12, his parents sent him to Rome, where he probably began his music education. By about 1680, he had attracted the attention of several wealthy patrons. Scarlatti moved to Naples in 1684.

Scarlatti, Domenico (1685-1757), was an Italian composer. He became famous for his sonatas for an early keyboard instrument called a *harpsichord*. Scarlatti composed about 550 harpsichord sonatas. He also wrote operas, cantatas, concertos, and fugues. Scarlatti greatly influenced later keyboard playing. His compositions were probably the first to require techniques that are still in use today. These techniques include frequently crossing the hands, *arpeggios* (fast successions of notes in a chord), and rapid repetitions of notes.

Scarlatti was born in Naples. His father was Alessandro Scarlatti, a famous opera composer. Little is known of the younger Scarlatti's music education. In the early 1700's, he lived in Lisbon, Portugal, where he taught harpsichord to Princess Maria Barbara. In 1729, she married Prince Ferdinand of Spain and moved to Madrid. At her request, Scarlatti followed her and spent the rest of his life in Spain.

Scarlet fever is an infectious disease that chiefly affects children. Its name comes from the bright red skin rash that develops during the illness. Scarlet fever was

once a serious and widespread disease. Since the 1950's, the disease has become less common in many countries.

Causes. Scarlet fever is associated with bacterial infections of the throat or skin. These infections are caused by bacteria called *group A beta-haemolytic streptococci* (see **Streptococcus**). Scarlet fever results if the bacteria produce a *toxin* (poison) that affects the skin, the surface of the tongue, and the throat.

Symptoms. When scarlet fever occurs along with pharyngitis, the first symptoms are those of the throat infection. These include sore throat, fever, headache, and swollen lymph nodes in the neck (see **Pharyngitis**). The scarlet fever rash generally becomes noticeable within two days after the illness begins. It resembles red goose pimples. It may spread over most of the body except the face. The tongue becomes severely inflamed, a condition called *strawberry tongue*.

After several days, the skin peels, particularly on the fingers, palms, toes, and soles of the feet. The inflamed surface of the tongue also peels, leaving a rough, red surface called *raspberry tongue*. In most cases, all signs of the disease disappear within two weeks.

The first symptoms of scarlet fever associated with skin infections vary according to the type of skin disorder. In the past, many cases followed the streptococcal infection of wounds. Today, most cases are associated with chickenpox or with streptococcal impetigo (see **Chickenpox**; **Impetigo**). After scarlet fever symptoms begin, most cases resemble a milder version of the disease associated with streptococcal throat infections.

Complications. Some scarlet fever victims later develop serious complications, particularly *rheumatic fever* or a kidney disease called *acute glomerulonephritis* (see **Rheumatic fever**; **Nephritis**). Acute glomerulonephritis may occur following scarlet fever associated with either throat or skin infections, but rheumatic fever does not develop after skin infections.

Treatment. Doctors generally prescribe penicillin to treat scarlet fever. This antibiotic kills the streptococci. Such treatment eliminates the risk of rheumatic fever, but it does not always prevent acute glomerulonephritis. Other medications may be used to relieve such symptoms as fever, headache, itching, nausea, or vomiting. Patients with scarlet fever should stay indoors for one day after beginning penicillin treatment. This precaution reduces the risk of spreading the disease.

See also **Disease** (tables).

Scarlet tanager. See **Tanager**.

Scenery. See **Theatre** (Set design); **Ballet** (Scenery).

Scepticism was a philosophical movement in ancient Greece. The Sceptics tried to weaken people's confidence in observation and reason as trustworthy guides to understanding the world, and they argued against all dogmatic schools of philosophy. They believed that people can be certain of the nature of their observations but cannot be sure that their observations reflect the real world. According to the Sceptics, people must suspend judgment regarding the truth or falsity of their perceptions.

There were two main schools of Scepticism in ancient Greece. The first school regarded Pyrrho of Elis, who lived from about 361 to 270 B.C., as its founder, and was called *Pyrrhonian Scepticism*. It was developed by Ane-

sidemus and is presented most fully in the writings of Sextus Empiricus, who lived about A.D. 200. The goal of this school was a tranquillity of life that follows from suspending judgment.

The second school of Scepticism was developed in the school of philosophy founded by Plato and was known as *academic Scepticism*. This school was begun by Arcesilaus in the 200's B.C. and continued by Carneades in the 100's B.C. These Sceptics were concerned with revealing the difficulties of other philosophers' points of view. Summaries of these Sceptic doctrines are preserved in Cicero's *Academica*.

See also **Carneades**; **Pyrrho of Elis**.

Scheele, Carl Wilhelm (1742-1786), was the Swedish pharmacist-chemist who discovered chlorine. He also prepared oxygen. But he did not publish his work in time, and Joseph Priestley, an English scientist, received credit. In 1770, Scheele discovered tartaric acid. He was also the first to obtain pure lactic, oxalic, citric, and hydrofluoric acids. He discovered Scheele's green (copper arsenite), molybdenum, and scheelite (calcium tungstate). Scheele was born in Stralsund, Germany, and as a boy became a pharmacist's assistant. He later opened his own chemist shop in Köping, Sweden, and made most of his discoveries there.

See also **Chlorine**; **Chemistry** (The phlogiston theory); **Molybdenum**.

Scheherazade. See **Arabian Nights**.

Schelde River is one of the most important commercial waterways of Europe, especially in Belgium. It rises southeast of Lille, France—where it is called the Escaut River—and flows northeast through Belgium. For location, see **Belgium** (terrain map). In Antwerp, Belgium, the river separates into the East Schelde and the West Schelde, which flow through the Netherlands to the North Sea. The Schelde is 435 kilometres long and is navigable for about 338 kilometres. Canals link the Schelde, Meuse, and Rhine rivers.

For about 200 years, the Dutch held the right to close the Schelde to ships. The Treaty of London of 1839, between Belgium and the Netherlands, gave the Netherlands permission to charge a toll for the use of the Schelde by Belgian vessels. These tolls were abolished in 1863. During World War I (1914-1918), the Netherlands closed the river to warships. During World War II (1939-1945), heavy fighting occurred along the Schelde and the Albert Canal, which connects the Schelde and Meuse rivers.

Schelling, Friedrich Wilhelm Joseph von (1775-1854), was a German philosopher. His earlier works are generally understood as an important link between Immanuel Kant and Johann Gottlieb Fichte on the one hand, and G. W. F. Hegel on the other. These works represent German idealism and romanticism. Schelling's *System of Transcendental Idealism* (1800) was the major work of his youth. He later criticized his own early works and Hegel's philosophy as "negative philosophy." Schelling attempted to develop a "positive philosophy" that stressed revelation and influenced existentialism.

Schelling was born in Leonberg, near Stuttgart, Germany. He entered the Tübingen theological seminary at the age of 16, and became a friend of Hegel and the poet Friedrich Hölderlin. Hegel, in the preface to his book *Phenomenology of Spirit* (1807), criticized Schel-

ling, though not by name, and their relation changed from collaboration to rivalry. Schelling became a prominent opponent of Hegel's philosophy.

Scherzo is a short, lively musical composition. The term is used to describe the third movement of a four-part symphony, sonata, or chamber music composition. Most scherzos feature a fast beat and abrupt changes in rhythm, and are humorous and playful. Scherzos also include a contrasting section called a *trio*. The trio in most cases is quieter and more melodious than the rest of the scherzo.

The German composer Ludwig van Beethoven introduced the scherzo in several works he wrote about 1800. Later masters of the scherzo form included Felix Mendelssohn of Germany, Anton Bruckner and Gustav Mahler of Austria, and Béla Bartók of Hungary.

Schiele, Egon (1890-1918), was an Austrian artist. He was one of the masters of expressionism in Austria during the early 1900's.

Schiele was influenced by the French impressionists early in his career but soon turned to the work of his fellow Austrian artist Gustav Klimt for inspiration. Schiele's style displays some of the decorative qualities and curved lines common to Klimt's art. However, Schiele was more concerned with capturing the emotional states of the human figure. He occasionally painted landscapes but generally devoted himself to portraying partly clothed or nude women and self-portraits. His figures are angular, thin, and twisted into unusual and uncomfortable poses. They suggest anxiety, tension, and



A Schiele portrait painted in 1916 illustrates the artist's skill at capturing the emotional states of his subjects.

Thyssen Bornemisza Collection, Lugano, Switzerland

violence, often combined with eroticism. The public found Schiele's work disturbing in its frank depiction of sexuality, and he was once briefly jailed on a morals charge. Schiele was born in Tulln and died in Vienna during an influenza epidemic.

Schiller, Johann Christoph Friedrich von (1759-1805), ranks second only to Goethe among the leading figures of German literature, and no German compares to him as a playwright. Schiller was a master of dramatic construction and character portrayal. His dramas are pleas for human freedom and dignity. They inspired German liberals in their fight for liberty during the early 1800's and during the Revolution of 1848.

Friedrich Schiller was born in Marbach in the Duchy of Württemberg. The Duke of Württemberg made him attend a military academy where he studied medicine, but he left his post as an army surgeon in 1782 to devote himself to writing. Schiller's early plays protested against the tyranny of the German aristocracy. His first drama, *The Robbers* (1781), enjoyed sensational success. His other early plays include the political-historical dramas *Fiesco* (1783) and *Don Carlos* (1787), and the middle-class tragedy *Intrigue and Love* (1784).

The period between 1787 and 1796 formed a separate part of Schiller's career. Unsure of his abilities as a dramatist, he turned to historical writing with *The Revolt of the Netherlands* (1788), a work dealing with the same period as *Don Carlos*; and *The History of the Thirty Years' War* (1791-1793). Schiller's literary talents injected a vivid dramatic quality into these works. Schiller's writings in the early 1790's on philosophy and aesthetic theory gave him an important place in the development of German idealism. His *Aesthetic Education of Mankind* (1793) established Schiller as the most important theorist of German classicism.

Schiller's friendship with Goethe from 1794 reawakened his interest in drama. His greatest drama, *Wallenstein* (1798-1799), is a tragedy set during the Thirty Years' War. It explores the relationship between a great individual and fate. The drama is a cycle of three parts, written in dignified blank verse. Three other historical plays followed. *Maria Stuart* (1800) deals with the life of the Scottish queen. *The Maid of Orleans* (1801) is the story of Joan of Arc. *William Tell* (1804) dramatizes Switzerland's struggle for freedom. *The Bride of Messina* (1803) is modelled on classical Greek drama.

Between 1785 and 1800, Schiller edited three literary magazines, to which he contributed many essays, lyrics, and stories. He became known for such philosophical lyrics as "The Song of the Bell." One of his most famous ballads is "The Diver." Two of his stories, "The Ghost-seer" and "The Criminal from Lost Honour," are early German short-story masterpieces.

See also **German literature** (The Storm and Stress movement).

Schipperke is a dog of Belgium. It is also known as the *Barge Dog* or *Little Skipper*, because it once guarded canal barges and hurried the horses that pulled them. The dog has a foxlike head with small, pointed ears. It has a heavy black coat with a longer *ruff* (frill of hair) on its neck. Some are born without a tail. In many others, the tail is *docked* (cut) to less than 2.5 centimetres. The dog weighs about 7 kilograms. See also **Dog** (picture: Nonsporting dogs).

Schism. See **Christianity** (The split between East and West).

Schism, Great. See **Pope** (The troubles of the papacy); **Roman Catholic Church** (The Great Schism).

Schistosomiasis is the name for a sometimes fatal disease caused by three species of parasitic worms called *schistosomes*. Schistosomiasis is widespread throughout the world and afflicts more than 200 million people in Africa, Asia, South America, and some Caribbean islands. It is also called *bilharziasis* in honour of the German physician Theodor Bilharz, who identified the disease in 1851.

The schistosomes that cause schistosomiasis have the scientific names *S. mansoni*, *S. japonicum*, and *S. haematobium*. (The *S.* stands for *Schistosoma*.) During part of their life cycle, these worms live as parasites in certain freshwater snails. After leaving snails, schistosomes swim about and may enter the skin of people who wade or swim in the waters. Eventually, the worms invade the bloodstream and settle in small veins near the bladder or intestines.

The adult male and female schistosomes live in close physical association. Eggs are passed daily into the blood vessels. Most eggs are discharged into the intestine and the bladder and are eliminated with the *faeces* (solid body wastes) and urine. However, some of the eggs may find their way into other organs, such as the liver and the spleen. The infected person's reaction to these eggs may cause disease.

The first sign of schistosomiasis infection is a temporary, itchy rash where the schistosomes have entered the skin. The main symptoms of the disease develop a few weeks later and include abdominal pain, coughing, discomfort, fever, nausea, and rash. Many patients experience diarrhoea and weight loss. Severe cases damage the liver, spleen, and intestines.

Doctors treat schistosomiasis with the drug praziquantel. Governments and health authorities try to prevent the disease by improving sanitation methods and by removing the snails from bodies of waters.

See also **Flatworm**; **Fluke**; **Aswan High Dam**.

Schizophrenia is a severe mental disease characterized by unpredictable disturbances in thinking. The word *schizophrenia* means a *splitting of the mind*. It refers to the characteristic schizophrenic behaviour of withdrawing from reality and thinking in illogical, confused patterns. The term does not mean that a victim has more than one personality.

Schizophrenia is one of the most common mental disorders. Most patients develop the disease from their late teens to mid-20's. Men tend to develop it earlier than women and often more severely.

Many people with schizophrenia develop delusions and behave as though they live in a fantasy world. They may hear "voices" that others cannot hear. The patients may believe that these "voices" carry messages from important people, or even from God. Schizophrenics often suffer disturbances in mood and behaviour. Some patients seem to feel no emotions, but others may display inappropriate emotions, such as laughing at sad situations. Some patients withdraw from their family and friends and talk mainly to themselves or to their "voices."

Doctors do not know the cause of schizophrenia. Genetic factors may be partly responsible for some cases.

Abnormal brain chemistry also plays a role. Certain chemicals called *neurotransmitters*, which allow nerve cells to communicate with each other, have been found to be at abnormal levels in some people with schizophrenia.

Before the 1950's, most people suffering from schizophrenia had to remain in mental hospitals. Since then, scientists have developed drugs that block the action of *dopamine*, a neurotransmitter, on certain nerve cells. In most cases, these drugs do not cure schizophrenia, but they usually reduce the symptoms so that most patients can leave the hospital. In addition, psychotherapy and rehabilitation programmes can help patients live outside the hospital. A small number of patients do not respond to treatment and must remain hospitalized.

See also **Mental illness** (Schizophrenia).

Schleswig-Holstein. See **Denmark** (The Schleswig wars).

Schlieffen Plan. See **World War I** (The Western Front).

Schliemann, Heinrich (1822-1890), was a German archaeologist who founded the study of ancient Greece and neighbouring cultures on the Aegean Sea. He and his wife, Sophia Engastromenos Schliemann, discovered the buried city of Troy in what is now Turkey. This city was made famous in the Greek epic the *Iliad*.

Guided by the *Iliad*, the Schliemanns started to excavate Troy in 1870. Through the centuries, nine cities had been built on the site. Each successive city stood on the ruins of the one before it. Near the bottom level, the Schliemanns found precious objects of bronze, gold, and silver in the city they believed was the Troy of the *Iliad*. Today, most scholars think the *Iliad*'s Troy was the seventh city from the bottom. The Schliemanns also explored Mycenae, an ancient Greek city. There, in 1876, they unearthed five royal graves full of jewels, weapons, and other treasures.

Schliemann was born in Neubukow. He earned a fortune as a businessman in Russia during the Crimean War (1853-1856). At the age of 41, he began to travel widely. After studying archaeology in Paris, he moved to Greece and spent the rest of his life studying ancient cultures.

See also **Aegean civilization**; **Mycenae**; **Troy**.

Schmalkaldic League was an alliance formed by the early German Protestants to defend themselves against Emperor Charles V and the Roman Catholic states. The league was formed in 1531, and the War of the Schmalkaldic League followed. The Protestants were defeated in 1547. But the league's aims were partly realized five years later in the Treaty of Passau. Charles V agreed to a temporary peace until a conference could settle matters. The conference, known as the Peace of Augsburg, took place in 1555. Under its terms, both Roman Catholic and Lutheran churches were legally permitted for the first time in Western Europe. See also **Reformation**.

Schmidt, Helmut (1918-), served as chancellor of West Germany from 1974 to 1982. In 1974, the country's *Bundestag* (lower house of parliament) elected Schmidt to succeed Willy Brandt, who had resigned from office. In the 1976 and 1980 general elections, a coalition of Schmidt's Social Democratic Party and the smaller Free Democratic Party won a majority of the seats in the *Bundestag*. Schmidt was reelected chancellor by the Bun-

destag following both elections. But in September 1982, the Free Democratic Party withdrew from the coalition. In October, the *Bundestag* gave a *vote of no confidence* to Schmidt's government, ending his term.

Helmut Heinrich Walde-mar Schmidt was born in Hamburg, Germany. He served in the German Army during World War II (1939-1945). Schmidt joined the Social Democratic Party in 1946. He graduated from the University of Hamburg in 1949. Schmidt served in the *Bundestag* from 1953 to 1962, when he became a government official in Hamburg. He was again elected to the *Bundestag* in 1965. He served in Brandt's cabinet as minister of defence, minister of economics, and minister of finance and economics.

Schnauzer. See **Giant schnauzer**; **Miniature schnauzer**; **Standard schnauzer**.

Schneider, Hannes. See **Skiing** (The development of modern skiing).

Schneider Trophy was raced for by pilots during the early days of aeroplane development. The race was held in many countries. It was open to seaplanes only. The competition took place for a cup given by Jacques Schneider, a French armaments maker. The French pilot Maurice Prévost won the first race in 1913 at an average speed of 73.63 kilometres an hour.

In 1929, a Supermarine S6 designed by Reginald Joseph Mitchell won at an average of 528.88 kilometres an hour (see **Mitchell, Reginald Joseph**). This seaplane influenced the design of many future aeroplanes, including the famous fighter, *Spitfire*. In 1931, Great Britain won the Schneider Trophy outright by winning it for three successive years.

Schnitzler, Arthur (1862-1931), was an Austrian writer whose works reflect the influence of Sigmund Freud's ideas on psychoanalysis. Schnitzler was born in Vienna. His plays and stories deal with the decline in morality, especially sexual morality, that he saw in middle-class and aristocratic Viennese society around 1900. Schnitzler was fond of the Viennese. Nevertheless, he exposed their weaknesses and shortcomings through subtle psychological probing, thereby displaying his mastery of characterization.

Schnitzler's two main themes are love and the nature of reality. Both appear in his play *Anatol* (1893), about a young man's adventures in love. The themes also appear in *Reigen*, also called *La Ronde* (published 1900, first performed 1912). This play is an intricate cycle of love affairs involving different classes of society. Schnitzler's best-known work of fiction is the short novel *Leutnant Gustl* (1901).

Schoenberg, Arnold (1874-1951), was perhaps the most influential composer of the 1900's. Schoenberg's name is also spelled *Schönberg*. In 1908, Schoenberg began to write music that was *atonal*—that is, lacking in key. Use of atonality eventually led to his formulation of the 12-tone system. In his 12-tone pieces, the melodic



Helmut Schmidt

and harmonic material of a piece is based on a specific ordering of the 12 notes of the chromatic scale, called a 12-tone row or set. This way of composing is called *serialism*.

Schoenberg first used atonality in parts of his String Quartet No. 2 of 1908 and all of the Three Piano Pieces (1909). His first work to use the 12-tone system throughout was Suite for Piano (1921-1923). Later and more sophisticated uses of this method include Variations for Orchestra (1928), Violin Concerto (1936), and String Quartet No. 4 (1937). In spite of his revolutionary method of composition, Schoenberg continued to write in such classical forms as sonata, song, and rondo.

Schoenberg was born in Vienna. He began writing in the late romantic tradition of such composers as Johannes Brahms, Richard Wagner, and Gustav Mahler. His early works include Five Pieces for Orchestra (1909, revised 1949), the expressionist operas *Erwartung* (1909) and *Die glückliche Hand* (1913); and *Pierrot Lunaire* (1912), a group of pieces for voice and chamber ensemble. Schoenberg moved to the United States in 1933 and became a U.S. citizen in 1941. He taught at the University of California, Los Angeles, from 1936 to 1944.

See also **Classical music** (The 1900's); **Opera** (The search for new forms).

Scholarship is a grant of money or free tuition awarded to a student on the basis of achievement, ability, or financial need. People usually consider a scholarship an honour in recognition of outstanding academic work, as well as financial aid to those who need it. Scholarships are generally awarded as a means of selecting and training capable people so that they may become assets to the community and nation.

Organizations in many countries award a number of scholarships to send students and teachers overseas. The purpose of such scholarships is to promote better international understanding and cultural relations. The oldest and most famous international scholarships are the *Rhodes Scholarships* (see **Rhodes Scholarship**).

Scholasticism was a philosophical system that emphasized the use of reason in exploring questions of philosophy and theology. The scholastics particularly tried to prove the truth of Christian doctrine. They also tried to reconcile contradictory viewpoints in Christian theology. Scholasticism had its greatest influence from the 1000's to the 1400's, especially during the 1200's. Most scholastics taught in the schools and universities of western Europe.

The scholastic method. The scholastics developed an extremely formal and sophisticated procedure of investigating philosophical and theological questions. Their method became known as the *disputed question*.

The disputed question started with a problem stated by the teacher. The students then listed the arguments for and against a certain solution to the problem. Next, the students took a position on the problem. Finally, they dealt, one by one, with the arguments on all sides of the problem. Using this method, the teacher and students tried to reach a balanced solution.

Scholastics analysed philosophical and theological questions in books called *books of sentences*. A book of sentences contained quotations or summaries of dogma compiled from the Bible, from works by early Christian writers, and—less often—from the works of other medi-

eval writers. If the quotations or summaries conflicted, the compiler tried to reconcile the conflicts by his own commentaries based on reason. The *Four Books of Sentences* (mid-1100's) by Peter Lombard became the standard theological textbook.

Scholasticism trained its followers to consider every side of a question logically and rationally. However, critics claimed that scholasticism relied so much on formal systems that it became artificial and inflexible. Critics also complained that scholasticism led to the assumption that every problem could be solved by reasoning.

History. Scholasticism originated during the 1000's in schools operated by cathedrals and monasteries. The writings on logic by the ancient Greek philosopher Aristotle had an important early influence on scholasticism. Aristotle had used logic to try to prove the existence of God.

Scholasticism reached its high point during the 1200's in western European universities. Many works by Aristotle that had been unknown to medieval philosophers were translated into Latin. For the first time, scholars could study a complete body of philosophy based on experience and reason alone. Until the translations of Aristotle's works, medieval philosophy had been based largely on the Bible and on writings by early Christian theologians. The scholastics tried to reconcile Aristotle's philosophy with Christianity. They also applied his philosophy to theological problems.

The major scholastics of the 1200's included Saint Albertus Magnus, Alexander of Hales, Saint Thomas Aquinas, Roger Bacon, Saint Bonaventure, and Robert Grosseteste. Aquinas, the most important scholastic, developed a philosophy that claimed to lead through reason alone to basic truths about God and the soul. But Aquinas believed that human beings need divine revelation to fill out and expand such knowledge.

In the 1300's, the scholastics John Duns Scotus and William of Ockham rejected Aquinas' emphasis on reason. They believed that God's actions and purposes are unpredictable and must be learned through revelation.

Beginning in the mid-1400's, scholasticism gradually lost its influence. Today, however, the teachings of some Roman Catholic theologians still reflect this influence.

Related articles in World Book include:

Abelard, Peter	Bonaventure, Saint
Albertus Magnus, Saint	Duns Scotus, John
Anselm, Saint	Lombard, Peter
Aquinas, Saint Thomas	Maritain, Jacques
Aristotle	William of Ockham
Bacon, Roger	

Schönberg, Arnold. See Schoenberg, Arnold.
Schongauer, Martin (1450?-1491), was one of the first German painters to work extensively as an engraver. He became the most skilful engraver in Europe during the 1470's and 1480's. His work greatly influenced younger artists, most notably Albrecht Dürer, and he was widely copied in many countries.

Schongauer's most famous paintings are the *Virgin in the Rose Arbor* (1473) and the large mural *Last Judgment* (about 1491) in Breisach. His best-known engravings include *The Death of the Virgin Mary*, *The Temptation of Saint Anthony*, and *Christ Bearing the Cross*.

Schongauer was born and worked in Colmar, Alsace (now in France).



Preschool class in North Korea



Elementary school classroom in Canada



High school chemistry lab in Mexico



University of California at Los Angeles, U.S.A.

The great variety of schools throughout the world is shown by the photographs above. All schools have the job of teaching people the skills needed in everyday life.

School

School is an institution that provides education. Most schools could be described as a building to which children and teenagers regularly go in order to learn reading, writing, mathematics, science, social studies, and the like. But some types of school are different from that basic description. For instance, numbers of Australian children who live on sheep stations far from any town are given daily instruction at home by means of radio or television. Their teacher is in a distant broadcasting studio. The pupils converse with a teacher by means of a talk-back radio system. This *school of the air* is not a building to which students go to learn, but it is a school. An *infant school* or *nursery school* has young children as pupils who may not study such subjects as reading, writing, and calculating. And what about a university in which adults enrol? Can that properly be called a school?

Therefore, to understand what *school* means to different people, it is helpful to answer these six questions: What school levels usually make up the *schooling ladder*? In what different kinds of settings does schooling take place around the world? What subjects are studied in schools? What sorts of supplies do different kinds of schools use? What kinds of people work in schools? Who controls and pays for schools?

The schooling ladder

The history of how schools get started in a community is quite similar from one country to another. The first school is usually intended for teaching beginning reading, writing, arithmetic, geography, history, and perhaps some religious knowledge. This first school that children attend usually offers what is called *primary*, *elementary*, or *basic* education. As pupils finish the six or eight years of primary school, they generally transfer to a *secondary school* for teenagers. Secondary education is often divided into two levels called *junior secondary* and *senior secondary*.

Young people who have finished secondary school at around ages 17 to 19 and who wish to pursue more advanced studies go to higher education institutions. At this *tertiary* level of education, the institutions are usually called universities, colleges, institutes, polytechnics, or academies. But some of them are called schools.

Many countries have special schools for children who are handicapped by blindness, by deafness, by a very low ability to learn, or by other special problems. Special schools may also be established for students who have exceptional talent in art, music, science, or drama. Many communities have infant schools, crèches,

nursery schools, preschool centres, or kindergartens for children aged 2 to 6.

Many countries throughout the world have introduced programmes under such mottoes as "Life-long Learning" or "Life-Span Education." They provide opportunities for adults to attend schools suited to their occupational needs or leisure-time interests.

Countries differ in the way they divide up the years between primary and secondary school. The most common pattern in the United Kingdom is a two-tier system—primary school for children aged 5 to 11 (in Scotland, 5 to 12) and secondary school for those aged 11 to 16 or 18. However, about 15 per cent of children in England attend a three-tier system—first schools (ages 5 to 8 or 9), middle schools (ages 8 to 12 or 9 to 13), and upper schools (ages 12 or 13 to 16 or 18).

The Republic of Ireland has an eight-grade *national* (primary) school followed by a three-year junior-secondary and a two-year senior-secondary school. Primary schooling in Australia covers either six or seven years, while secondary education is divided into a junior (3 or 4 years) and senior (2 years) sequence. New Zealand follows an eight-year primary and five-year secondary plan.

In India, basic education lasts eight years, with those eight years often divided into two segments labelled *primary* (5 years) and *middle* (3 years). The subsequent four years of India's secondary education comprise a two-year lower level and a two-year upper level. Malaysia's system consists of primary (6 years), lower secondary (3 years), and upper secondary (2 years) schools, followed by a two-year form-6 level.

The United States has a variety of ways of dividing up the 12 years of primary and secondary schooling, but two patterns are particularly common. The most common is an arrangement of elementary (6 years), junior-high (3 years), and senior-high (3 years) schools introduced in the early 1900's. The other arrangement is an elementary (8 years) and high-school (4 years) design carried over from the 1800's.

School settings

The *school setting* is the place in which lessons are taught. In all nations the most frequent setting is a classroom with desks or tables for the students, a desk for the teacher, and a blackboard at the front of the room. In large cities, there are often dozens of classrooms in the same building. In small towns, the typical primary school building may have only six or eight classrooms, one for each standard or grade. In small villages in the mountains or jungles, there may be only one or two classrooms in a school, with pupils of several different ages studying together in the same room.

In addition to these typical kinds of classrooms, schooling takes place in many unusual settings. For example, in parts of Africa and Asia nomad families live in tents so they can easily travel from one region to another during the year to find grazing land for their cattle and sheep. Children from those families often go to school in a tent, where they sit on the ground or on a carpet rather than on chairs while they listen to the teacher and work on their lessons. To educate gypsy children who travel about with their parents, some countries provide *mobile teachers* who drive from place to place in buses equipped as *mobile classrooms*.

In Arab nations of the Middle East and North Africa, as well as in Pakistan, Malaysia, and Indonesia, most people are Muslims, belonging to the religion of Islam. There are also many Muslims in India. For centuries, Islamic religious teachers have operated schools in which young people study the Islamic holy book, the Quran, and other religious teachings. Quran schools are often in a rural area rather than in a large city. Frequently students live at the school in small dormitory rooms where they study and sleep. They may pay for their education by working in the fields that surround the school or by providing some other kind of labour for their teacher. To receive instruction, they may meet in their teacher's house or in a *mosque* (an Islamic place of worship). During class periods they usually sit cross-legged on mats.



A school of the air in Australia uses two-way radio to teach children who live on farms and sheep stations far from any town. This boy is learning elementary science by doing simple experiments in his home under the guidance of a distant teacher.

In regions of Africa, Asia, and South America where no school building is yet available, a teacher may give lessons in an open field, with the pupils sitting on the ground in front of a portable blackboard. In remote mountain areas of China, a large cave has sometimes served as a school.

Typical subjects taught

In all countries the basic topics that most pupils study are very much the same. The subjects taught in nearly every primary school include reading and writing the local language, arithmetic, social studies (which are often history and geography), natural science, health education, music, art, and physical activities. In many countries an hour or two each week is also used for religious or moral education. The courses offered by a school are called its *curriculum*. Sometimes these subjects are all listed in the schools' curriculum guidebook, but not all of them are taught in every classroom. When teachers feel they are not trained well enough to give instruction in science, art, or music, they may leave those subjects out of their daily lessons. Or a teacher may spend so much time giving instruction in reading, writing, and arithmetic that there is no time for other subjects.

From time to time the people in charge of the schools will change the emphasis placed on certain subjects. For example, in 1990, the Malaysian government passed a law requiring every student to enrol in religious education class, thus making religious studies compulsory rather than optional as they had been since the 1960's. In contrast, legislation in Spain made religious education voluntary. At the same time, authorities in Sri Lanka required that prayers be said during the morning and at the end of the school day.

The curriculum in junior-secondary schools usually includes the same subjects as those in primary schools, but with the subjects taught at a more advanced level. The study of a foreign language and some introductory vocational education (subjects providing skills needed for a career, such as industrial arts, home economics)

are often added at the junior-secondary level. In senior-secondary schools, the curriculum typically becomes more differentiated, so that some students concentrate on science courses while others specialize in literature and languages, general university-preparatory topics, business practices, industrial arts, and the like.

In much of the world, the central government decides which subjects will be taught in all schools. This is the case in Finland, France, Greece, Japan, Malaysia, Singapore, Taiwan, Western Samoa, and many more countries. In other nations, however, the decision about students' list of studies is left up to individual states or provinces or to the headmasters and teachers of local schools. This is the practice in Australia, Canada, India, and the United States. In still other countries, part of the curriculum is determined in the nation's capital city and part in the local schools. In 1988, the UK government, for example, departed from its long tradition of allowing local schools to decide on the curriculum and established a list of subjects to be taught in all schools. The national curriculum comprises three core subjects (English, mathematics, science) and seven "foundation" subjects. To equip students with modern technical skills, the UK national curriculum includes computer education as a required topic.

Supplies and equipment

The most familiar supplies in schools around the world are desks, a large blackboard, textbooks, and a few maps and wall charts. Secondary schools and universities usually also provide special equipment for classes in science (microscopes, chemistry glassware, biology exhibits), in music (band and orchestra instruments), in art (clay, paints, weaving looms), in physical education (balls, playing fields, swimming pools), and in vocational studies (typewriters, sewing machines, electric saws, electric drills, construction tools).

Communities that are able to spend more money on supplies will increase the number of books in school libraries, will buy radio and television sets for class-



An art classroom has special supplies and equipment. It has a water supply and sink; drawing boards; storage for paints, paper, and brushes; examples of sculptures; and a press for printmaking. Posters and samples of pupils' work decorate the walls.



In India, a town school provides education for children who cycle in from outlying rural areas. Schools such as this one, left, in Pondicherry provide secondary education for all children up to the age of 14. But some children leave school earlier in order to help support their families.

rooms, and will provide projectors for showing films, charts, and photographic slides. Throughout the world, computers are rapidly being added as classroom equipment. Regions with sufficient money often furnish several computers for every classroom. In some secondary schools, every student has a computer to use.

The quantity of classroom supplies differs greatly from one country to another, and even from one school to another. Richer schools provide students with large numbers of books as well as a wide variety of maps, videocassettes for television receivers, science equipment, computers, musical recordings, art supplies, business machines, and vocational-education equipment for teaching carpentry, electronics, car repair, machine-shop work, home economics, and the like. In contrast, students in communities that have little money for schools often lack even one textbook. Pupils may have no pencils or paper. It is obvious that students in schools that offer a wide range of books and equipment have a better chance to learn efficiently than do students in schools that are unable to provide even enough basic textbooks for the learners.

The profitable use of supplies in a classroom depends not only on the amount of money a school spends on equipment but also on the ingenuity of teachers in creating and using instructional materials. The following description of two classrooms for 14-year-old pupils illustrates how greatly teaching facilities may differ from one sort of school to another.

An ultramodern classroom. This classroom is in a very modern city school that has ample funds for purchasing the most advanced technical equipment. At each student's desk is a small microcomputer with a keyboard for typing information and a screen on which to view what has been typed. Students write their lessons on the microcomputer. In addition to the keyboard, a small microphone attached to the computer allows the student to enter information into the computer by talk-

ing. What the student says into the microphone appears immediately in printed form on the screen. A printer at the edge of the desk enables the student to print a paper copy of any information stored in the computer, such as an essay or story the student has composed or the student's answers to test questions. A set of earphones attached to the computer allows the student to hear music or speech stored in the computer.

At the front of this ultramodern classroom, the teacher has a larger computer—called a *computer console*—that is connected to all of the students' units. The teacher can transmit information to the students' computer screens, such as reading material, still pictures or moving pictures, descriptions of science experiments, or test questions. This same information can be sent to all of the students at the same time, or else the teacher can send special information to only one or two students. Therefore, the teacher is able to give particular instruction to individual learners who need special help. The students' task of writing assignments on their computers is simplified by their having an automatic spelling-corrector available in each computer.

Instead of a blackboard at the front of a classroom, there is a large television screen connected to a laser-disc player. The player is a machine into which metal discs—like large gramophone records—are inserted. Each disc contains 85,000 pictures, graphs, or charts that give items of information about thousands of topics studied in school. Any of these items can be shown on the television screen at the touch of a button. The teacher and students can select a series of items that will form a special lesson about science, history, geography, music, sports, the arts, or many other topics. The lesson can then be shown on the screen in full colour, with high-quality pictures and sound.

In addition to the laser discs, an instrument called a *modem* is connected to the classroom telephone, enabling the class to receive television programmes or



An ultramodern classroom has advanced technical equipment, such as computers and laser printers.

to display information from distant libraries on the students' computers or on the large television screen. Pupils can compose their own specially designed workbooks or textbooks by selecting segments of information from the distant library sources and printing the information on the classroom's computers.

With such facilities available, the teacher can bring much of the world into the classroom through the great wealth of pictures and charts available. Students can constantly improve their thinking and writing skills by completing frequent assignments on their classroom computers.

A school in a poor rural region. The second example is typical of classrooms found in many parts of the world, particularly in economically poor, rural areas of Africa, Asia, and South America. The facilities are very meagre. The classroom has woven bamboo walls. A few

openings cut in the walls let in light. There are wooden benches and tables for the students, and a small blackboard hangs at the front of the room. In this school, the teacher and students are unusually resourceful in creating instructional materials that improve their learning opportunities.

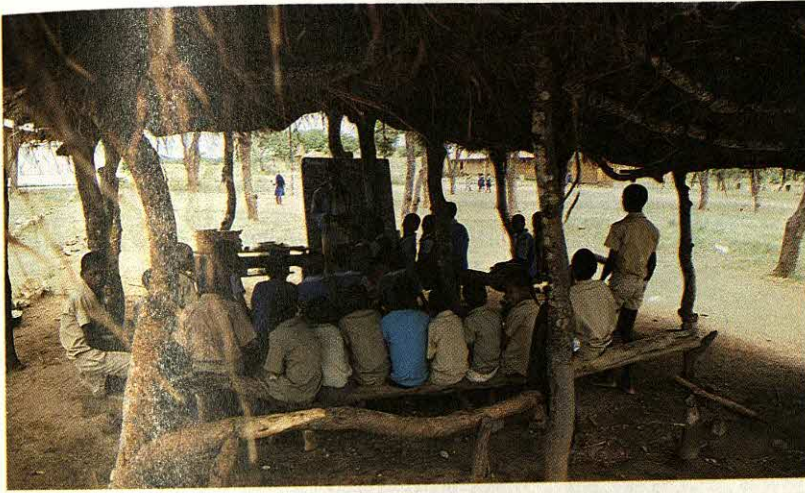
The teacher has only one textbook for teaching reading, one for mathematics, one for history, and one for science. No pupil has his or her own textbook. The students create additional texts by copying the original four books by hand as a homework assignment. They have obtained the paper for that project by writing letters to a large oil company in the country's capital city, pointing out the school's lack of textbooks. They asked for writing paper, crayons, and discarded roll-up window blinds on which they can draw maps of their village, their country, and the world. The maps can then be displayed on the classroom walls. Because paper is so scarce, pupils write their daily lessons with chalk on dark wooden planks. They make their own chalk sticks out of material from a nearby limestone quarry.

Since the school cannot afford library books, the students have been creating their own booklets as part of their history and literature projects. One history assignment requires students to interview elderly people in the village to learn what life was like in their community in the past. After pupils write descriptions of their interviews, their compositions are bound together to form a library booklet called "Our Village History." By this same means, handwritten library resources have been created on other occasions by pupils conducting interviews about "Jobs in Our Community," "Legends and Folk Tales," "Water Supplies," "Our Religion," "Preparing Foods," "Caring for Animals," and more. The students have borrowed some books as sources of information for writing compositions that could become part of library booklets on such topics as first aid, simple science experiments, and famous heroes.

For their study of science, the students have collected and classified objects from the surrounding area, then



In Brazil, children attend school for free education between the ages of 7 and 14. This primary school is in a settlement area in Rondônia, in the Amazon region.



In Zimbabwe, a school uses a covered, open-air classroom to provide shade and shelter. Summer in Zimbabwe's subtropical climate is hot and rainfall is heavy.

displayed their collections as classroom exhibits. The objects include rocks, plants, insects, types of wood, glassware, fabrics, leather goods, and tools. Guided by a government booklet entitled *How to Conduct Simple Science Experiments*, class members have gathered items from around the village to carry out research on such topics as plant growth, weights and measures, chemical changes, and the strength of materials.

This example indicates that even in poor regions teachers and students can improve learning opportunities by creating their own instructional materials.

The people who work in schools

Not only may communities differ in the kinds of classroom supplies they provide, but they also may differ in the kinds of people who staff their schools. The one type of person found in all schools throughout the world is the teacher. The next most common is the headmaster or headmistress (sometimes called the *principal*) who is responsible for scheduling classes, ordering supplies, hiring new teachers, talking with parents, and perhaps carrying out disciplinary actions against pupils who fail to obey school rules. In smaller schools, one of the teachers—often known as the *head teacher*—may serve as the principal.

In larger schools that have sufficient funds, additional employees may include special teachers to aid pupils who suffer handicaps, such as children who have difficulty learning to read, are hard of hearing, or are blind. Many schools also provide counsellors who offer students advice about their future educational programmes and about how to plan for an occupation in the future.

A type of employee that has become increasingly popular in a wide range of countries is the *teacher's aide*. An aide is a person who works under the supervision of a classroom teacher to help individual pupils and to assist with such tasks as correcting tests and preparing learning materials. Aides are often older students or parents who may have no special training in teaching and who learn their job under the direction of the teacher in whose classroom they serve.

In addition to teachers, schools may employ a variety of staff members—clerks, secretaries, building caretak-

ers, and specialists in the use of such electronic equipment as computers and videotape recorders.

Nearly every nation issues regulations about what kind of educational preparation a teacher should have in order to be placed in charge of a classroom of pupils. The length of training required for entering a teaching career varies from one country to another. In developing nations that are short of funds, the length of teachers' preparation may be as brief as one year at the secondary-school level. In economically advanced nations, training can be as long as four or five years of study in a university. Less training is usually required for nursery-school and kindergarten teachers than for those who will work in the elementary grades. Secondary-school instructors are typically expected to have more



School employees may include specialist teachers, such as a musician who trains the school orchestra, *top*, and caterers who provide midday meals, *bottom*.



A well-equipped school laboratory needs ample funds. This school in London receives a government grant and additional, voluntary contributions.

training than primary-school teachers, and university instructors require the most preparation of all.

The control and funding of schools

Schools can be controlled and financed either by a government or by a private group of citizens. Throughout most of the world, the term *state* or *public* identifies schools that are organized, controlled, and funded by a government. The word *government* here can mean a local village, a city, a province, or an entire nation. In contrast, *private* means a school operated by a group of people who wish to keep the control of schooling in their own hands. The group may be a large religious body, such as the Roman Catholic church, which sponsors thousands of schools, or it may simply be a collection of parents who wish to provide a local school. Usage differs in the United Kingdom. There, a *public school* traditionally refers to some independent, or private, schools. However, this usage is gradually dying out.

The ratio of state to private schools can differ greatly from one country to another. For example, around 75 per cent of students in Australia attend state institutions and 25 per cent of students attend private schools, nearly all of which are under church sponsorship. In the Republic of Ireland, each primary school is managed by a local board made up of parents, teachers, and representatives of a church; most of these schools' funds are provided by the government. Ireland's secondary schools are mainly private, most of them owned and managed by religious groups. About two-thirds of Singapore's schools are operated and financed by the government, while the remainder are private institutions that receive government funds to pay salaries and development costs.

For many years, schools in nations under Communist governments were entirely state-run. With the changes that took place in Eastern Europe's Communist governments at the beginning of the 1990's, however, permission was being granted by many governments to open private schools.

Schooling throughout the world has long been a cooperative effort between governments and private groups. This pattern of government and private cooperation is likely to continue in the future.

Related articles. See the *Education* and *People* sections of various country articles. See also the following articles:
 Degree, University Kindergarten Special education
 and college Nursery school University
 Education

Outline

- I. The schooling ladder
- II. School settings
- III. Typical subjects taught
- IV. Supplies and equipment
 - A. An ultramodern classroom
 - B. A school in a poor rural region
- V. The people who work in schools
- VI. The control and funding of schools

Questions

What subjects may special schools concentrate on?
 About how long does schooling last in primary school?
 What other school settings are there other than classrooms?
 What is meant by a *curriculum*?
 Who decides the subjects that are taught in schools?
 What is *vocational* education?
 What sort of equipment may be found in an ultramodern classroom?
 What sort of equipment may be found in a poor, rural school?
 What is a *teacher's aide*?
 Which teachers need the longest training time?

School (of water animals). See *Dolphin* (Group life); *Fish* (How fish live together); *Pilot whale*; *Sardine*; *Whale* (Group life).

Schooner. See *Sailing* (with picture).

Schopenhauer, Arthur (1788-1860), was a German philosopher who became widely known for his pessimistic views and his fine prose style. Schopenhauer was strongly influenced by the German philosopher Immanuel Kant. Following Kant's argument, Schopenhauer insisted that the world we experience through our senses is mere *representation*. By this he meant that we experience the world not as it really is, but only as we represent it to ourselves. In representing the world to ourselves, we change it.

Both Kant and Schopenhauer argued that we represent objects as existing in space and time, and we represent all events as having a cause. But according to these philosophers, space, time, and causality are not really properties of the world. Instead they argue, we add them to our experience of the world. They are the structures we always necessarily use to organize our experience. But the price we pay for this ordering is never knowing the world as it really is—that is, as it exists apart from the structures we add to the world as we experience it.

Schopenhauer believed that we can at least know ourselves without introducing this distortion. In addition to knowing ourselves as we know other things, we also experience ourselves from the inside as individuals making choices and willing certain desired ends. As Schopenhauer expressed it, we experience ourselves as *will* as well as *representation*. In knowing ourselves as will, we know ourselves apart from the structures of space, time, and causality. Thus, we know ourselves as we really are. For Schopenhauer, the real inner nature of the world is will.

Schopenhauer's pessimism was based on his belief that the will can never really be satisfied. According to Schopenhauer, the will is either striving for something that it unhappily does not yet possess, or it quickly experiences the boredom that invariably follows the attainment of any goal. Given the impossibility of ever satisfying the strivings of the will, Schopenhauer advised us to dissociate ourselves as much as possible from these strivings. He suggested that one important way of achieving this withdrawal is through the quiet contemplation of natural and artistic beauty.

Schopenhauer was born in Danzig (now Gdańsk, Poland). At his father's urging, he began training for a career in business. But he turned to philosophy after his father's death. Schopenhauer's first book is *On the Fourfold Root of the Principle of Sufficient Reason* (1813). His most important work is *The World as Will and Representation* (1819, second edition 1844). A collection of essays titled *Parerga and Paralipomena* (1851) brought Schopenhauer international fame toward the end of his life.

Schreiner, Olive (1855-1920), was one of the most distinguished South African writers. She has been acknowledged as a pioneer in her treatment of women and in her fictional use of the African landscape. She was the first colonial writer to be accepted into the London literary world.

Olive Emile Albertina Schreiner was born in Cape Colony, the daughter of a missionary. Largely self-educated, she began writing while working as a governess. By the time she made her first trip to the United Kingdom, in 1881, Schreiner had already completed her best known work, *The Story of an African Farm*. She published it in 1883 under the pseudonym "Ralph Iron." Set against the African veld, the novel deals with the lives of two orphaned cousins, Em, who is reserved, and Lyndall, who is unconventional. Lyndall's rejection of marriage and conventional morality makes the novel typical of the "New Woman" fiction of the late 1800's. While in England, Schreiner met many famous literary and political people. She returned to South Africa in 1889, where she married Samuel Cronwright, a politician, in 1894.

Schrödinger, Erwin (1887-1961), an Austrian theoretical physicist, became known for his mathematical equation describing the wavelike behaviour of electrons. Schrödinger shared the 1933 Nobel Prize for physics with the British physicist Paul Dirac for this work and for his other contributions to atomic theory.

Schrödinger developed his equation, now known as the "Schrödinger equation," in 1925 and introduced it in 1926. He based it on the ideas of Louis V. de Broglie, a French physicist, who in 1924 had proposed a theory that electrons behave like waves. The Schrödinger equation became the basis of a version of a field of physics that is called *quantum mechanics* (see **Quantum mechanics**).

In later years, Schrödinger concentrated on expanding Albert Einstein's theory of gravitation to include electrical and magnetic phenomena. Schrödinger was also interested in the impact of science and technology on philosophy. His short book *What Is Life? and Other Scientific Essays* (1956) details his concerns. He also wrote *My View of the World* (1961).

Schrödinger was born in Vienna. He served as a professor of theoretical physics in several German and Swiss universities. He also was associated with the Dublin Institute for Advanced Studies.

See also **De Broglie, Louis V.**; **Dirac, Paul A. M.**
Schubert, Franz Peter (1797-1828), an Austrian composer, wrote an astonishing variety of music in many forms. He was one of the greatest creators of melody, and perhaps the foremost composer of *lieder* (German art songs).

His life. Schubert was born in Vienna on Jan. 31, 1797. He was the son of a poor schoolmaster. By the time he was 11, he was a choirboy. He attended school at the Imperial and Royal Seminary, and played the violin and sometimes conducted there. Schubert was composing when only 13, and wrote his first song the next year. He began his first symphony in 1813. He was 17 when he wrote the well-known song "Gretchen at the Spinning Wheel." In 1815, he wrote such lieder as "Hedge Roses" and "The Erl King," as well as his second and third symphonies, and several works for the musical stage.

Schubert taught for a time in his father's school, then went to live with his friend Ferdinand Schober in 1816.

Schubert's operas failed to earn much money, and he suffered greatly from poverty because he lived a disorganized and easygoing life. In 1826, he tried, but failed, to get a position at the court of the Austrian emperor. Although he composed constantly and gained some recognition, Schubert managed to get only a few of his works published. He never achieved real success.

Schubert planned to visit Hungary in 1828, the year in which he composed several major works. But he became very ill, and had to abandon the trip. On Nov. 14, 1828, Schubert contracted typhus. He died five days later.

Schubert was the classic example of a man of genius who was so devoted to his art that he never managed to live well or adjust to the world. He never married. His music and his personal charm won him admiring friends, but he gained little public recognition. Schubert heard only a few of his great orchestral works performed, and his great *Symphony in C major* was not performed during his lifetime. Ten years after his death, his brother Ferdinand gave the manuscript to Robert Schumann. Schumann in turn gave it to Felix Mendelssohn, who conducted the work in Leipzig. Ferdinand made many of Schubert's other works available for publication.

His works. Schubert's orchestral works include dances, overtures, and symphonies. The two-movement *Symphony No. 8 in B minor* ("Unfinished") has long been a public favourite. Many regard Schubert's *Symphony in C major* (known either as No. 7 or No. 9), as his greatest masterpiece. His charming chamber music varies from an octet and two quintets to many string quartets and



Detail of a watercolour portrait (1825) by Wilhelm August Rieder. Historisches Museum der Stadt Wien

Franz Schubert

piano trios, as well as sonatas for piano and violin. Schubert also wrote many pieces for solo piano, notably sonatas, *impromptus*, waltzes, and *Moments Musicaux* (Musical Moments). He also composed many works for piano duet.

Schubert was especially attracted to the musical possibilities of the human voice. He composed much religious music, including Masses, and choral pieces to nonreligious texts. He wrote several operas and operettas. But these works lacked theatrical effectiveness and failed on that account. However, Schubert's incidental music for the play *Rosamunde, Princess of Cyprus*, is still popular.

Schubert's special contribution to music lies in his more than 600 solo lieder. These include the *cycles* (groups of related songs) called *Die schöne Müllerin* (*The Beautiful Mill-Girl*), *Winterreise* (*Winter Journey*), and *Schwanengesang* (*Swan Song*). Such separate songs as "Ave Maria," "Death and the Maiden," "Serenade," "The Trout," and "Who Is Sylvia?" are among the greatest in song literature. No other composer has written so many expressively beautiful songs of such high quality. See **Lieder**.

Schubert was not a man of tough and searching intellect like Beethoven, a man he admired greatly. Schubert sometimes was unable to sustain his musical ideas once he had presented them in larger forms. Some critics feel that many of his sonatas are too long for the musical ideas they contain. But Schubert was especially gifted in creating melody, and his poetic inspirations easily carry the listener through some perhaps needless repetition. This problem does not arise in his astonishing lieder. These songs would undoubtedly give Schubert a place among the great composers even if he had written nothing more.

Schulz, Charles Monroe (1922-), an American cartoonist, created the "Peanuts" comic strip. His simply drawn characters are children who make funny but wise statements about life. Charlie Brown, Lucy, Linus, and the others—including Snoopy, the dog—appeal to both children and adults.

Schulz was born in Minneapolis, Minnesota. He based much of the Charlie Brown character on his own childhood. Schulz had trouble with his studies because he missed two years of schooling. In secondary school, he did poorly in sports and was too shy to ask a girl for



Popular "Peanuts" characters created by Charles Schulz include, from left to right, Lucy, Linus, Charlie Brown, Peppermint Patty, Sally, Woodstock the bird, and Snoopy the dog.

a date. The school yearbook even rejected the cartoons he submitted. But Schulz continued to draw and, in the late 1940's, he began selling cartoons to magazines and newspapers. In 1950, he started "Peanuts," with Charlie Brown, a born loser, as the main character of the strip. "Peanuts" appears in more than 2,000 newspapers in the United States and Canada and in newspapers in about 65 other countries.

Schumann, Clara (1819-1896), was one of the finest pianists of her time and the wife of the German composer Robert Schumann. She was also a composer. Schumann included passages from many of her works in his compositions.

Clara Schumann was born in Leipzig, Germany. She studied with her father, Friedrich Wieck, a famous piano teacher. Wieck opposed her engagement to Schumann, another of his pupils, but the couple were married in 1840. While raising their eight children, Clara Schumann found time to learn hundreds of piano works. She became the first pianist to play entire concerts from memory.

In 1853, the Schumanns met the composer Johannes Brahms, who became their devoted friend. Brahms and Clara Schumann encouraged performances of her husband's works after Schumann died in 1856. From 1872 to 1892, she headed the piano department at the Frankfurt Conservatory.

See also **Schumann, Robert**.

Schumann, Robert (1810-1856), was a German composer and writer on music. Some critics consider him the most important composer of the German romantic movement. He became best known for his brilliant piano compositions and beautiful songs.

His works. Schumann's compositions represent the two contrasting moods of romantic music. One mood is emotional, impulsive, and stormy, and the other is quiet and reflective.

Schumann's chief works for piano include *Sym-*

phonie Etudes (1834), *Fantasia in C major* (1836), and *Concerto in A minor* (1845). He also composed a number of short pieces, many of which he organized in groups. These include *Papillons* (1829-1831), *Carnaval* (1834-1835), *Kinderszenen* (1838), and *Kreisleriana* (1838). His *Album for the Young*, a collection of pieces for piano students, was published in 1848.

Schumann composed four symphonies; chamber and choral music; an unsuccessful opera, *Genoveva* (1850); and other works. His songs rank with those of Franz Schubert among the finest German *lieder* (art songs). In 1840, the year he married, Schumann wrote over 100 songs.

Schumann had a strong influence on various composers of the late 1800's, especially Johannes Brahms of Germany and Edvard Grieg of Norway. He also influenced several French and Russian composers.



Lithograph (1839) by Josef Kriehuber; Photo Archives and Portrait Collection, Austrian National Library, Vienna

Robert Schumann

In 1833, Schumann helped found the *Neue Zeitschrift für Musik*, a leading music journal. He edited the journal from 1835 to 1844 and wrote many articles for it until 1853. These articles did much to establish the early reputation of such composers as Brahms of Germany, Hector Berlioz of France, and Frédéric Chopin of Poland.

His life. Schumann, the son of a bookseller and publisher, was born in Zwickau. He began piano lessons at the age of about 7. In 1828, Schumann entered the University of Leipzig with the goal of studying law. But he neglected his studies and devoted most of his time to music and writing. After a year at the University of Heidelberg, he returned to Leipzig in 1830. Schumann studied piano under the noted teacher Friedrich Wieck. But he injured a finger in 1832, which forced him to abandon his hopes for a career as a concert pianist.

About 1835, Schumann fell in love with Wieck's 16-year-old daughter Clara, a brilliant pianist. Wieck felt that Clara was too young and Schumann's future too uncertain for marriage. Despite his objections, the couple were married in 1840 (see **Schumann, Clara**).

Schumann began to show signs of mental illness in the early 1840's, and he later suffered a severe breakdown. He accepted the position of musical director of the Düsseldorf symphony orchestra in 1850, but his increasing mental illness caused difficulties in his relations with the musicians. Schumann resigned in 1853. Early in 1854, he tried to commit suicide by jumping into the Rhine River. He was rescued and placed in an asylum, where he died.

Schuster, Sir Arthur (1851-1934), was a physicist who contributed to the discovery of the electron. He suggested that the conducting power of the upper atmosphere of the earth is caused by ultraviolet rays from the sun. He was a professor at Manchester University, England, where he built a laboratory. Schuster was born at Frankfurt am Main in Germany, but went to Manchester when he was 19. He began a business career, but later turned to science, which he studied at Owens College, Manchester, and the University of Heidelberg, in Germany.

Schwann, Theodor. See **Cell** (Cell research).

Schweitzer, Albert (1875-1965), was a brilliant philosopher, physician, musician, clergyman, missionary, and writer on theology. His accomplishments in any one of these fields could be regarded as a full life's work for one person.

Schweitzer has been called one of the greatest Christians of his time. Early in his career, he based his philosophy on what he called "reverence for life" and on a deep feeling of obligation to serve humanity through thought and action. Schweitzer's many years of work as a humanitarian won for him the 1952 Nobel Peace Prize.

His life. Schweitzer was born on Jan. 14, 1875, at Kaisersberg, a town near Strasbourg in the region of Alsace, Germany (now France). He was educated in both France and Germany. At the age of 21, Schweitzer decided to spend his next nine years in science, music, and preaching, and then to devote the rest of his life to serving humanity directly. Before he was 30, he had won an international reputation as a writer on theology, as an organist and authority on organ building, as an interpreter of the works of Johann Sebastian Bach, and as an authority on Bach's life.



Albert Schweitzer, a man of many accomplishments, even designed all of the buildings in his hospital and leper colony.

In 1902, Schweitzer became principal of St. Thomas Theological College at the University of Strasbourg. He was inspired to become a medical missionary, and studied medicine from 1905 to 1913 at the university. Schweitzer raised money for a hospital at Lambaréné, French Equatorial Africa (now Gabon), from his parishioners and by giving concerts for the Paris Bach Society, which he had helped found. In 1913, he began serving at Lambaréné.

Schweitzer's first consulting room was a chicken coop. Over the years, he built a large hospital and a medical station where thousands of Africans were treated yearly. Schweitzer used his Nobel Prize money to expand the hospital and establish a leper colony.

His books. Schweitzer continued to write while in Africa. He completed in 1923 the first two volumes of his monumental work *The Philosophy of Civilization*. These books are *The Decay and Restoration of Civilization* and *Civilization and Ethics*. His other works include *The Quest of the Historical Jesus* (1906), *Out of My Life and Thought* (1931), and *From My African Notebook* (1939). *The Problem of Peace in the World Today* (1954) was the address he gave on receiving the Nobel Prize.

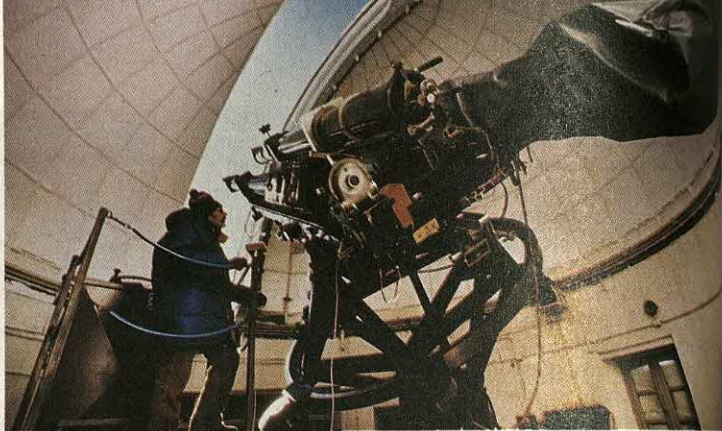
In 1955, Queen Elizabeth II conferred Great Britain's highest civilian award, the Order of Merit, on Schweitzer. In 1957, Schweitzer went on record as opposing further atomic weapons tests because of the danger of radioactive fallout to human beings.

Sciatica refers to pain along the *sciatic nerve*. The sciatic nerve extends from the pelvis down the back of each leg to the foot. This large nerve controls feeling and movement in the leg and foot.

The most common cause of sciatica is pressure on one of the nerve roots that form the sciatic nerve. For example, pressure from a ruptured *intervertebral disc* in the lower spine may cause sciatica. In such cases, part of the tissue that makes up the disc protrudes from the vertebrae of the spine and presses on a nerve root. The person feels pain in the leg and foot, as well as the spine. Treatment for most cases of sciatica consists of manipulation, analgesics, bed rest and certain exercises. In some cases, surgery is required to relieve the pressure on the nerve.



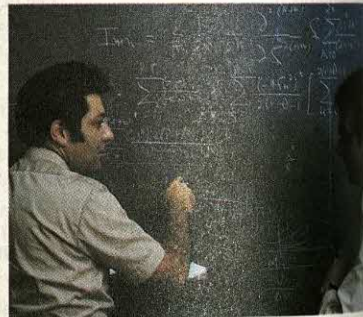
A biologist studying a photo of viruses



An astronomer readying his telescope



Archaeologists working at a dig



Mathematicians solving problems

The world of science consists of many fields of study. For example, scientists may investigate the structure of galaxies or the way tiny organisms function. They may explore the remains of past cultures or prove mathematical statements. New areas of scientific research are continually emerging.

Science

Science covers the broad field of knowledge that deals with observed facts and the relationships among those facts. The word *science* comes from the Latin word *scientia*, which means *knowledge*. Scientists study a wide variety of subjects. For example, some scientists search for clues to the origin of the universe. Other researchers examine the structure of molecules in the cells of living plants and animals. Still others investigate why we act the way we do, or try to solve complicated mathematical problems. But in whatever field they work, all scientists explore the workings of the world.

Scientists use systematic methods of study to make observations and collect facts. They then work to develop theories that help them order or unify related facts. Scientific theories consist of general principles or laws that attempt to explain how and why something happens or happened. Science advances as scientists accumulate more detailed facts and gain a better understanding of these fundamental principles and laws.

A theory developed by a scientist cannot be accepted as part of scientific knowledge until it has been verified by the studies and experiments of other researchers. In fact, for any knowledge to be truly scientific, it must be repeatedly tested experimentally and found to be true. This characteristic of science sets it apart from other branches of knowledge. For example, the *humanities*,

which include religion, philosophy, and the arts, deal with ideas about human nature and the meaning of life. Such ideas cannot be scientifically proved. There is no test that tells whether a philosophical system is "right." No one can determine scientifically what feeling an artist tried to express in a painting. Nor can anyone perform an experiment to check for an error in a poem or a symphony.

Science also differs from other types of knowledge in that scientific progress depends on new ideas expanding or replacing old ones. Great works of art produced today do not take the place of masterpieces of the past. But the theories of modern scientists have revised many ideas held by earlier scientists. Repeated observations and experiments lead scientists to update existing theories and to propose new ones. As new discoveries continue to be made, even many recent scientific theories will become outdated and will have to be replaced by better theories that can explain more facts. In this way, scientific knowledge is always growing and improving.

The importance of science

Science has enormous influence on our lives. It provides the basis of much of modern *technology*—the tools, materials, techniques, and sources of power that make our lives and work easier. The term *applied sci-*

ence is sometimes used to refer to scientific research that concentrates on the development of technology. The discoveries of scientists also help shape our views about ourselves and our place in the universe.

To everyday life. Modern science and technology have changed our lives in many dramatic ways. Aeroplanes, cars, communications satellites, computers, plastics, and television are only a few of the scientific and technological inventions that have transformed human life. Research by nuclear physicists has led to the development of nuclear energy as a source of power. Agricultural output has soared as scientists have developed better varieties of plants and highly effective fertilizers. The development of antibiotics and other new drugs has helped control many infectious diseases. Studies in anatomy and physiology have led to amazing new surgical techniques and to the invention of lifesaving machines that can do the work of such organs as the lungs, kidneys, and heart.

Although scientific and technological achievements have benefited us in numerous ways, they have also created serious problems. The rapid growth of industrial technology, for instance, has resulted in such grave side effects as environmental pollution and fuel shortages. Breakthroughs in nuclear research have led to the development of weapons of mass destruction. Some people fear that advanced biological research will produce new disease-causing bacteria or viruses that resist drugs. People are also concerned that computerized information systems may destroy personal privacy.

The harmful effects of some technological applications of science have led some people to question the value of scientific research. But science itself is neither good nor bad. The uses that businesses, governments, and individuals choose to make of scientific knowledge determine whether that knowledge will help or harm society. For a more detailed discussion of the benefits and side effects of technology, see **Technology**.

To philosophical thought. Science has greatly affected the way we view ourselves and the world around us. In ancient times, most people believed that natural events and everything that happened to them resulted from the actions of gods and spirits. For example, they thought that angry gods and evil spirits caused disease.

The ancient Greeks were among the first peoples to begin to use systematic observation and reasoning to analyse natural happenings. As scientific thinking gradually developed, nature came to be seen less and less as the product of mysterious spiritual forces. Instead, people began to feel that nature could be understood and even controlled through science.

Over the years, scientific findings have increasingly influenced philosophical and religious thought about the nature of human beings and their place in the universe. In the mid-1500's, for example, the Polish astronomer Nicolaus Copernicus proposed that the earth and the other planets travel around the sun. Although his theory was later proved to be correct, it stirred strong opposition among philosophers and religious leaders of the time. They had long believed that the earth and the people on it had special importance because the sun, stars, and planets revolved around the earth.

The theories developed by the British naturalist Charles Darwin in the mid-1800's also aroused bitter

philosophical and religious debates. Some philosophers and religious leaders opposed Darwin's idea that all species of plant and animal life *evolved* (developed gradually) from a few common ancestors. They felt that this theory of evolution contradicted the belief that God created human beings and gave them special emotional and intellectual gifts. These debates continue today. During the late 1800's and early 1900's, the Austrian doctor Sigmund Freud developed a theory that unconscious motives control much of human behaviour. His research and writings have raised serious questions about the extent to which people have free will and are responsible for their behaviour. See **Evolution** (Acceptance of evolution); **Freud, Sigmund** (His influence).

Since 1900, new scientific theories have begun to alter philosophical views about the nature of reality and the limits of our ability to observe it accurately. In 1905, for instance, the German-born physicist Albert Einstein published his special theory of relativity. The theory dramatically changed some of the most basic ideas about time, space, mass, and motion. For example, it stated that observations of space and time are not absolute. They are affected by the motion of the observer. See **Relativity**.

The branches of science

Scientific study can be divided into four major groups: (1) mathematics and logic, (2) the physical sciences, (3) the life sciences, and (4) the social sciences. Within these main categories are many smaller groupings of closely related specialities. For example, anthropology, psychology, and sociology are *behavioural sciences* included in the category of the social sciences. Geology, meteorology, physical geography, and physical oceanography are grouped together as the *earth sciences* within the category of the physical sciences.

As scientific knowledge has grown and become increasingly complicated, many new fields of study have emerged. At the same time, the boundaries between scientific fields have become less and less clear-cut. Numerous areas of science overlap, and it is often hard to tell where one science ends and another begins. For instance, both chemistry and physics deal with atomic structure. Both palaeontology and geology study the age of rocks in the earth. Many of the most important scientific advances have resulted from the exchange of ideas and methods among different branches of science.

In some cases, sciences have come to overlap so much that *interdisciplinary* fields have been established. Such fields combine parts of two or more sciences. For example, *biochemistry* combines areas of biology and chemistry in studying the chemical processes that occur in living plants and animals. *Economic geology* draws upon economics and geology in investigating the distribution of such natural resources as gold, silver, and petroleum.

World Book has separate articles on many of the branches of science discussed in this section. For a complete listing of these articles, see the *Related articles* at the end of this article.

Mathematics and logic are not based on experimental testing. But they can be considered part of science because they are essential tools in almost all sciences.

tific study. Mathematics enables scientists to prepare exact statements of their findings and theories and to make numerical predictions about what will happen in the future. Logic provides the basis for all scientific reasoning.

Mathematics has a number of major branches. *Arithmetic*, which furnishes the basis for many of the other branches of mathematics, is the study of numbers and of methods for calculating with numbers. *Algebra* involves solving *equations*, mathematical sentences that say two expressions are equal. In algebraic equations, letters are used to represent unknown quantities. *Calculus* is used to solve problems dealing with changing quantities. *Geometry* concerns the mathematical relationships of points, lines, angles, surfaces, and solids in space. *Probability* deals with the likelihood that an event will occur. *Statistics* is used to analyse large amounts of numerical information for significant trends.

Scientific reasoning depends on both *deductive logic* and *inductive logic*. In using deductive logic, a scientist reasons from known scientific principles or rules to draw a conclusion relating to a specific question. The accuracy of the scientist's conclusion depends on the accuracy and completeness of the principles or rules used. Inductive logic requires a scientist to make repeated observations of an experiment or an event. From the many observations, the scientist can form a general conclusion. See **Deductive method**; **Inductive method**.

The physical sciences examine the nature of the universe. They study the structure and properties of nonliving matter, from tiny atoms to vast galaxies. The physical sciences include (1) astronomy, (2) chemistry, (3) geology, (4) meteorology, and (5) physics.

Astronomy is the study of comets, meteors, galaxies, planets, stars, and other objects in space. Astronomers map the locations of heavenly bodies and investigate the physical and chemical processes that occur in celestial objects. They also study the structure, composition, size, and history of the universe.

Chemistry studies natural and artificial substances to determine their composition and structure and the changes that occur when they combine and form other substances. Chemists take molecules apart and put them together in new ways. They try to find out why chemical reactions occur and how they can be controlled. *Organic chemistry* deals with most compounds containing the element carbon, and *inorganic chemistry* concerns all other compounds. *Radiochemistry* investigates radioactive substances and their uses. *Stereochemistry* examines the different chemical properties that result when compounds of the same formula differ in the relative position of their atoms in three-dimensional space. *Physical chemistry* studies the effects of light, heat, and other forms of energy on chemical processes.

Geology investigates the composition, structure, and history of the earth. Geologists analyse how such forces as earthquakes, volcanic eruptions, and wind or water erosion change the earth's surface. They also study meteorites and materials brought back from the moon. Branches of geology include *petrology*, the study of rocks; *mineralogy*, the study of minerals; and *seismology*, the study of earthquakes. *Geochronology* seeks to determine the age and history of the earth and its parts. **Meteorology** is the study of the earth's atmosphere

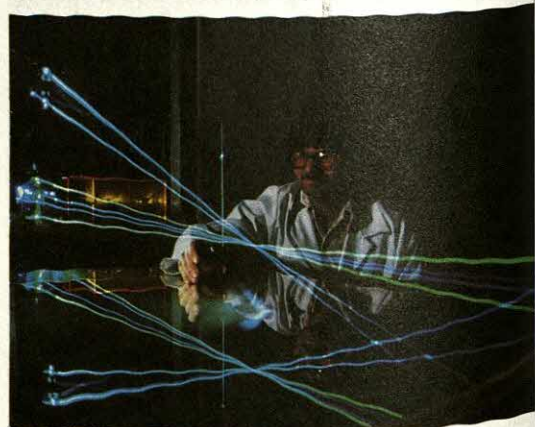
and the conditions that produce weather. Meteorologists try to predict the weather. They work to develop improved instruments for collecting data about the atmosphere. They also seek better techniques to make weather forecasting more exact. *Climatologists* analyse weather trends to determine the general pattern of weather that makes up an area's climate.

Physics is concerned with matter and energy. Physicists study mechanics, heat, light, sound, electricity, magnetism, and the properties of matter. *Atomic physics* involves the study of the structure and properties of atoms, and *nuclear physics* focuses on the makeup and behaviour of the nuclei of atoms. *Particle physics* deals with the nature of electrons, protons, and other tiny bits of matter smaller than atomic nuclei. *Cryogenics* examines the behaviour of matter at extremely low temperatures, and *plasma physics* investigates the behaviour of ionized gases at exceptionally high temperatures. *Solid-state physics* studies the properties of extremely pure crystals and other solid materials.

The life sciences, also called the *biological sciences* or *biology*, involve the study of living organisms. There are two main fields of the life sciences. *Botany* deals with plants, and *zoology* with animals. Botany and zoology are further divided into various branches, each of which can be subdivided into areas of special study. Most major branches of the life sciences apply equally to plants and animals. Many of the branches, such as anatomy and physiology, overlap with, and contribute greatly to, the study of medicine. See **Medicine**.

Anatomy examines the structure of living things. Anatomists investigate the parts of organisms and how the parts are related. *Histology* deals with tissues, and *cytology* with the fine structures of individual cells. *Comparative anatomy* studies similarities and differences in the body structure of animals and provides clues to how certain animals might have evolved.

Physiology deals with the normal functions of living things and their parts. For example, physiologists study how nerve fibres transmit impulses and how organisms take in and use food. *Biochemistry* examines the chemical processes that are involved in the actions of the different parts of plants and animals. *Biophysics* investi-



Modern technology plays a key role in almost every area of scientific research. The physicist above is using *lasers* (concentrated beams of light) in measuring airstream velocity.

gates the physical processes involved in the functioning of the various parts of living things.

Other branches. The field of *genetics* is concerned with how plants and animals pass on characteristics to their offspring. *Molecular biology* examines the structure and function of proteins and other large molecules essential to life. *Palaeontology* investigates the forms of life that existed in prehistoric times. *Taxonomy* involves the classification of living things. *Sociobiology* deals with the biological basis for the social behaviour of people and other animals. *Ecology* focuses on the relationships living things have to one another and to their environment.

Some life sciences concentrate on certain kinds of organisms. For example, *bacteriology* is the study of bacteria, and *ornithology* is the study of birds. Some other life sciences investigate the organisms that live in a specific environment. *Marine biology*, for instance, studies the plants and animals of the sea.

The social sciences deal with the individuals, groups, and institutions that make up human society. They focus on human relationships and the interactions between individuals and their families, religious or ethnic communities, cities, governments, and other social groups. Social scientists attempt to develop general "laws" of human behaviour. But their task is difficult because it is hard to design controlled experiments involving human beings. Social scientists must therefore rely heavily on careful observations and the systematic collection of data to arrive at their conclusions. The use of statistics and mathematical models is important in analysing information and developing theories in the social sciences. The main branches of the social sciences include (1) anthropology, (2) economics, (3) political science, (4) psychology, and (5) sociology.

Anthropology investigates the origin and development of human cultures and of human physical characteristics. Anthropologists study various groups of people to determine their similarities and differences. They compare the arts, beliefs, customs, daily life, inventions, languages, social relationships, and values of different cultures. *Archaeology* traces cultural development by studying the things earlier peoples made and used.

Economics examines how people produce goods and services, how they distribute them among themselves, and how they use them. Economists deal with problems in such areas as management and labour relations, the setting of wages and prices, and the use of natural resources. They use computers and statistical analysis to construct mathematical models that enable them to determine how various economic systems work and to predict the effect of changes in the systems.

Political science studies forms of government, political parties, pressure groups, elections, and other aspects of politics. Political scientists try to develop theories about political power and behaviour and seek to discover what kinds of government may benefit people the most under given circumstances. They also measure public opinion.

Psychology involves investigation of mental processes and behaviour. *Physiological psychologists* study how the nerves and the brain work. *Behavioural psychologists* observe and record the ways in which people and other animals relate to one another and to the

environment. They use systematic methods to examine people's thoughts, feelings, and personality traits. Psychologists also explore the causes of mental disorders and possible methods of treatment.

Sociology studies the nature, origin, and development of human society and community life. Sociologists investigate the interrelationships among individuals and groups in a society. They examine cultural influences, standards of behaviour, and other factors that can affect general social conditions. They also explore the causes of crime, divorce, poverty, and other social problems.

How scientists work

Scientific research is a creative process that can involve a variety of techniques. Important advances may result from patient hard work or sudden leaps of imagination. Even chance can play a role in the scientific process. For example, Sir Alexander Fleming, a British bacteriologist, discovered penicillin accidentally in 1928, when he noticed that a bit of mould of the genus *Penicillium* had contaminated a laboratory dish containing bacteria. Examining the dish, Fleming saw that the bacteria around the mould had been killed.

Scientists use a number of methods in making discoveries and in developing theories. These methods include (1) observing nature, (2) classifying data, (3) using logic, (4) conducting experiments, (5) forming a *hypothesis* (proposed explanation), and (6) expressing findings mathematically. Most scientific research involves some or all of these steps.

Observing nature is one of the oldest scientific methods. For example, the ancient Egyptians and Babylonians studied the motions of heavenly bodies and so learned to predict the changes of seasons and the best times to plant and harvest crops. In the 1830's, Charles Darwin carefully observed plants and animals in many parts of the world while serving as a naturalist with a British scientific expedition aboard the H.M.S. *Beagle*. Study of the specimens collected on the voyage helped Darwin develop his theory that modern species had evolved from a few earlier ones.

Classifying data can reveal the relationships among observed facts. In the mid-1800's, Dmitri Mendeleev, a Russian chemist, classified the elements into families or groups in a chart called the *periodic table*. On the table, elements with similar properties appeared at regular intervals. Gaps in the table indicated elements that were not yet known. Scientists later proved the importance of Mendeleev's systematic classification when they discovered the existence and chemical properties of new elements that filled the gaps.

Using logic enables scientists to draw conclusions from existing information. In the late 1800's, a German physicist named Wilhelm Wien studied the relationship between temperature and the energy radiated by heated solids and liquids. After studying many specific examples, he noted that multiplying the temperature of a heated solid or liquid by the wavelength of greatest intensity radiated at that temperature always produced the same number. Although Wien could not test all solids and liquids, he used inductive reasoning to conclude that this number was a *universal constant* which was the same for all heated solids and liquids, regardless of their physical or chemical makeup.

Conducting experiments is a major tool in developing and testing scientific theories. The Italian astronomer and physicist Galileo was one of the first scientists to recognize that systematic experimentation could help reveal the laws of nature. In the late 1500's, Galileo began performing carefully designed experiments to study the basic properties of matter in motion. By rolling balls of different weights down inclined planes, he discovered that all objects fall to the ground with the same *acceleration* (rate of increase in speed), unless air resistance or some other force slows them down. In the early 1600's, William Harvey, an English doctor, used the experimental method to learn how blood circulates through the body. He made careful studies of the human pulsebeat and heartbeat and *dissected* (cut up) human and animal corpses for examination. Harvey concluded that the heart pumps blood through the arteries to all parts of the body and that the blood returns to the heart through the veins.

Forming a hypothesis requires talent, skill, and creativity. Scientists base their proposed explanations on existing information. They strive to form hypotheses that help explain, order, or unify related facts. They then use experimentation and other means to test their hypotheses. The discovery of the planet Neptune in the mid-1800's resulted from the formation of a hypothesis. Astronomers noticed that Uranus, which they thought was the most distant planet, was not always in the position predicted for it by the laws of gravitation and motion. Some astronomers concluded that the laws did not hold at such great distances from the sun. But others hypothesized that the variations in the orbit of Uranus might be

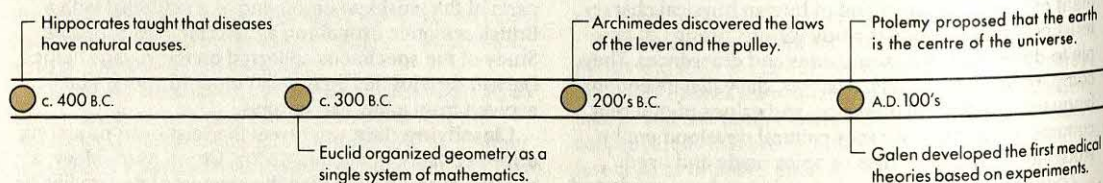
caused by the force of gravity from an unknown planet. By calculating where such a planet would have to be located to affect the orbit, astronomers eventually discovered Neptune.

Expressing findings mathematically can yield valuable insights about how the world works. Galileo used mathematics to express the results of his experiments with falling bodies and to enable him to determine the distance an object would fall in a certain amount of time. The English scientist Sir Isaac Newton developed a mathematical theory of gravitation in the 1600's that explained many types of motion, both on the earth and throughout the universe. In the early 1900's, the German-born physicist Albert Einstein found that mass is related to energy by the equation $E = mc^2$. The equation states that *energy* (E) is equivalent to *mass* (m) multiplied by the *speed of light squared* (c^2). This equation later provided the basis for the development of nuclear energy.

The history of science

From earliest times, people have been curious about the world around them. Thousands of years before civilization began, people learned to count and tried to explain the rising and setting of the sun and the phases of the moon. They studied the habits of the animals they hunted, learned that some plants could be used as drugs, and acquired other basic knowledge about nature. These achievements marked the beginnings of science. They were among the first attempts to understand and control nature. In general, mathematics and medicine were the first sciences to develop, followed by the physical sciences, life sciences, and social sciences.

Highlights in the history of science



Egyptian geometry dealt with surveying land and other practical matters. This papyrus from the 1500's B.C. shows calculations of the area of a field.



Aristotle, right, the great Greek philosopher, studied many areas of science in the 300's B.C. He emphasized careful observation in his scientific studies.



Arab astronomers of the A.D. 800's and 900's mapped the heavenly bodies. The Arabs also made major advances in mathematics, medicine, and optics.

Early civilizations. The sciences developed by the peoples of the first civilizations dealt chiefly with practical matters. For example, mathematics was used to record business and government transactions. Astronomy provided the basis for keeping time and determining when to plant and harvest crops. As early as 3000 B.C., the Egyptians studied the heavens to forecast the arrival of the seasons and to predict when the annual flooding of the Nile River would occur. The Egyptians used geometry to establish property lines and to make the measurements needed to build huge pyramids. They also learned some anatomy, physiology, and surgery through embalming their dead.

In ancient Babylonia, the people used a system of counting in units of 60, which is the basis of the 360-degree circle and the 60-minute hour. They understood fractions, squares, and square roots. They also developed complicated mathematical models of the motions of the planets and other heavenly bodies. Their detailed observations of the sky enabled them to predict solar and lunar eclipses and other astronomical events.

The Chinese and Indian civilizations developed a little later than the Egyptian and Babylonian cultures. By the 300's B.C., the Chinese had mapped the major stars in the heavens and, like the Babylonians, succeeded in predicting eclipses. The ancient Chinese had their own system of mathematics. They also developed acupuncture and other medical practices that have been handed down almost unchanged to the present. Medicine in ancient India dealt with the prevention as well as the treatment of illness. Indian surgeons performed many kinds of operations, including amputations and plastic sur-

gery. Early Indian mathematicians invented the Hindu-Arabic numerals that we use today.

The earliest advanced cultures in the Americas also had a working knowledge of astronomy and mathematics. One of the first major civilizations was that of the Olmec Indians of Mexico, who developed a counting system and a calendar between 1200 and 100 B.C. By about A.D. 250, the Maya of Central America and Mexico were studying the motions of the sun, moon, stars, and planets from observatories. They used their astronomical knowledge to develop religious and civil calendars. The Maya also had an advanced mathematical system. During the 1400's, the Aztec Indians of Mexico and the Inca Indians of Peru ruled powerful empires. Carvings on a famous "Calendar Stone" left behind by the Aztec represent the regular motions of the heavenly bodies, as well as religious symbols and symbols for the days of the month. The Inca used mathematics in constructing buildings and roads.

Ancient Greece. The Greeks left the greatest scientific heritage of all the ancient peoples. They stressed developing general theories about the workings of the world and were the first to begin systematically to separate scientific ideas from superstition.

About 400 B.C., a Greek doctor named Hippocrates taught that diseases have natural causes and that the body can repair itself. He was the first doctor known to consider medicine a science apart from religion. During the 300's B.C., Aristotle, one of the greatest Greek philosophers, studied many areas of science. Aristotle gathered vast amounts of information about the variety, structure, and behaviour of animals and plants. He

Leonardo da Vinci studied anatomy, astronomy, botany, and geology.

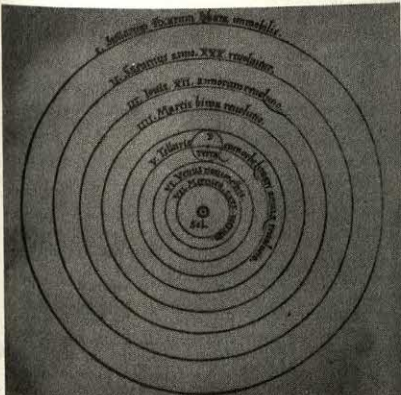
c. 1500

1609

Johannes Kepler established astronomy as an exact science.

William Harvey published his theory of how the blood circulates.

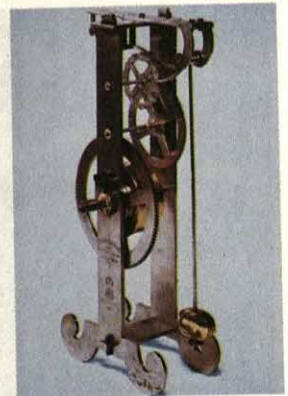
1628



The sun-centred theory is shown in this diagram from *On the Revolutions of the Heavenly Spheres* (1543) by Nicolaus Copernicus of Poland. His work revolutionized astronomy.



Andreas Vesalius wrote the first scientific text on human anatomy. His book, *On the Fabric of the Human Body*, appeared in 1543.



A pendulum clock from 1641 was designed by Galileo, who saw the need for precise scientific instruments.

showed the need for classifying knowledge and recognized the importance of observation. He also developed deductive logic as a means of reaching conclusions.

Greek mathematics was more advanced than that of any other ancient culture. The Greeks became the first people to separate mathematics from purely practical uses and to develop systematic methods of reasoning to prove the truth of mathematical statements. By 300 B.C., Thales, Pythagoras, Euclid, and other Greek mathematicians had perfected geometry as a single logical system. The Greeks believed that the study of mathematics could yield absolutely certain and eternal knowledge. For example, once a principle of geometry was proved, it remained true for all time.

Some Greek scientists had an interest in practical affairs. During the 200's B.C., for instance, the Greek mathematician and inventor Archimedes performed experiments in which he discovered the laws of the lever and the pulley. The discoveries led to the construction of machines that could easily move heavy loads.

The Greeks mapped the stars and measured the size of the earth with surprising accuracy. The astronomers used the circle, which they considered the perfect mathematical form, as their model for the heavens. They worked out various mathematical models and mechanical systems that explained the motions of the planets in terms of circular paths. In the A.D. 100's, Ptolemy, one of the greatest astronomers of ancient times, presented his ideas and summarized those of earlier Greek astronomers in the *Almagest*. In this work, Ptolemy stated that the sun and the planets moved around the earth in circular orbits. Astronomers accepted versions of Ptole-

my's *geocentric* (earth-centred) theory of the universe for more than 1,400 years.

Although the ancient Greeks made many important scientific advances, their approach to science had limitations. Believing mathematics to be eternally true, unchanging knowledge, the Greeks never saw that it could be used to analyse the physics of motion and other constantly changing properties of nature. Nor did the Greeks discover the importance of testing their observations systematically. Many of their conclusions were false because they were founded on "common sense" instead of experiments. For example, Aristotle mistakenly thought, on the basis of common sense, that heavier objects fall to the earth faster than lighter ones.

Ancient Rome. By the A.D. 100's, the city of Rome had conquered much of the known world, including the areas of Greek civilization. The Romans were excellent architects, engineers, and builders. But they contributed little to theoretical science. Under Roman rule, scholars continued to accept the scientific knowledge of the Greeks. Many Roman doctors came from the Greek-speaking world, and the Romans employed Greek tutors or sent their children to Athens and other centres of Greek learning for advanced education.

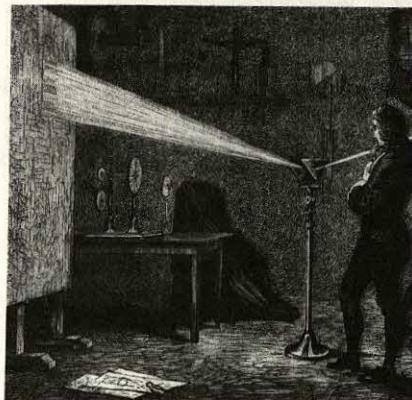
Although the Romans themselves made few scientific discoveries, vast encyclopedias of scientific knowledge were written under Roman rule. In a 37-volume work called *Natural History*, the Roman author Pliny the Elder gathered the scientific learning of his day. A Greek geographer and historian named Strabo described all parts of the known world in his 17-volume *Geography*.

The Greek doctor Galen, who practised medicine

Robert Hooke used the microscope to uncover the world of cells.

Mid-1600's

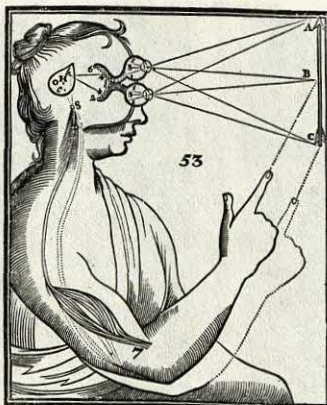
Robert Boyle helped establish the experimental method in chemistry.



Experiments with prisms conducted in the 1600's by Sir Isaac Newton of England began the modern study of optics. Newton demonstrated that sunlight is a mixture of light of all colours.

Early 1700's

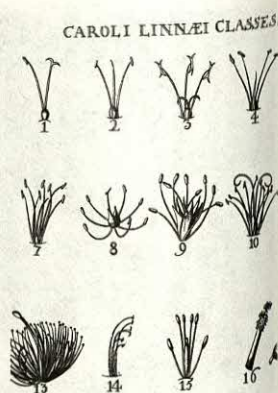
Carl Scheele and Joseph Priestley independently discovered oxygen.



Human vision was explained in geometric terms by René Descartes, a French philosopher of the 1600's. He held that mathematics was a model for all sciences.

Adam Smith published the first complete work on classical economics.

1776



Scientific classification of plants and animals was begun by Carolus Linnaeus of Sweden in the 1700's.

in Rome during the A.D. 100's, developed the first medical theories based on scientific experiments. Galen dissected animal corpses for study and greatly advanced the knowledge of anatomy. However, he had many false notions about how the human body works.

The Middle Ages was a 1,000-year period in European history that began in the A.D. 400's. For hundreds of years after this period began, little scientific investigation took place in Europe. Most scholars were more interested in *theology*, the study of God, than in the study of nature. They relied on Greek and Roman writings for scientific information and saw no need to make observations of their own. Aristotle, Euclid, Galen, and Ptolemy were considered the authorities on science. But many of the ancient works used by European scholars of the Middle Ages were poorly preserved. Errors were introduced as copies were made, and the contents of the works were often inaccurately summarized.

Meanwhile, Arabs in the Middle East preserved much of the science of ancient Greece and Rome. They carefully translated many Greek and Roman texts into Arabic. Through their conquests, they came into contact with Persian astronomy, history, and medicine, and with the Indian system of numbers and decimal numeral system.

Arabic scientists also made important contributions of their own in astronomy, mathematics, medicine, optics, and other sciences. An Arab mathematician named al-Khwarizmi organized and expanded algebra in the early 800's. Avicenna, an Arab doctor of the late 900's and early 1000's, produced a vast medical encyclopedia titled the *Canon of Medicine*. It summed up the medical knowledge of the day and accurately described meningitis, tetanus, and many other diseases. During the early 1000's, an Arab physicist known as Alhazen recognized that vision is caused by the reflection of light from objects into our eyes. In spite of their many scientific achievements, the Arabs did not use experimental methods or develop the instruments or applied mathematical techniques that were necessary to the development of modern science.

During the 1000's, European scholars began to show a renewed interest in science. Many major Arabic scientific works were introduced into Europe and translated into Latin, the language of learning in the West. The Hindu-Arabic number system also spread to Europe, where it stimulated the development of mathematics and began to be used in business. Some theologians of the 1100's and 1200's, such as Peter Abelard of France and Thomas Aquinas of Italy, started systematic efforts to bring Christian teachings into harmony with rediscovered scientific ideas. During the 1100's, the first European universities were established. In time, universities were to play a vital role in the growth of science.

Relatively few medical advances occurred in Europe during the Middle Ages. Doctors relied on the teachings of Galen, rather than make new discoveries based on their own observations and studies. Epidemics frequently swept across Europe. In the mid-1300's, for example, a terrible outbreak of bubonic plague called the Black Death killed about a fourth of Europe's population. To treat or prevent diseases, many people continued to depend on magic and superstition.

The rebirth of science in Europe began in 1543 with the publication of two books that broke scientific tradi-

Antoine Lavoisier discovered the nature of combustion.

James Clerk Maxwell developed his electromagnetic theory.

1777

1830

1860's

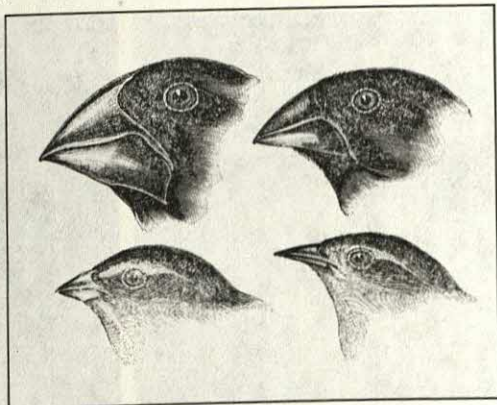
Charles Lyell showed that the earth has changed slowly through the ages.



Michael Faraday, shown in his laboratory at the Royal Institution in London, produced a current with a moving magnet in 1831.



Drawings of cells by Theodor Schwann of Germany in the 1830's helped prove cells make up all organisms.



Beak adaptations in finches on the Galapagos Islands were noted by the British naturalist Charles Darwin. Darwin used such species variations to support his theories of evolution, which he set forth in *The Origin of Species* (1859).

tion. One book was written by the Polish astronomer Nicolaus Copernicus, and the second by Andreas Vesalius, an anatomist born in what is now Belgium.

Copernicus' book, called *On the Revolutions of the Heavenly Spheres*, challenged Ptolemy's view that the earth was the centre of the universe. Ptolemy's geocentric theory required a complicated series of circular motions to account for astronomers' observations of how the planets appeared to move. Copernicus realized that if the earth and other planets travelled around the sun, a less complicated arrangement of circles could explain the observed motions of the planets. But his *heliocentric* (sun-centred) theory still did not accurately predict the motions of all the planets.

During the 1500's, a Danish astronomer named Tycho Brahe observed the motions of the planets far more precisely than they had ever been observed before. Brahe's work enabled Johannes Kepler, a German astronomer and mathematician, to lend new support to the heliocentric theory in 1609. Kepler used intricate calculations to show that the theory could explain the movements of the planets if the planets orbited the sun in *elliptical* (oval) paths rather than circular ones. The elliptical shape of the orbits would also make it easier to account for the movements of the planets. Kepler's work marked the start of modern astronomy.

The second tradition-breaking book published in 1543 was Vesalius' *On the Fabric of the Human Body*. In this work, Vesalius laid out in detail the most precise anatomical knowledge of the day. He based the book on observations he made in dissecting human corpses. His book gradually replaced those of Galen and Avicenna.

The scientific revolution. During the late 1500's and early 1600's, scholars and scientists increasingly realized the importance of experimentation and mathematics to scientific advances. This realization helped bring about a revolution in science. The great Italian scientist Galileo stressed the need for carefully controlled experiments. In his research, Galileo used observation and mathematical analysis as he looked for cause and effect relationships among natural events. He recognized that experimentation could lead to the discovery of new principles. For example, Aristotle had taught that the heavier an object is, the faster it falls to the ground. Galileo questioned that idea. He set up experiments to find the true laws of falling bodies and proved that Aristotle was wrong. Through experimentation, Galileo discovered many basic principles of mechanics.

Galileo also saw the need to extend the range and power of the human senses with scientific instruments. He improved such instruments as the clock and telescope. With the telescope, Galileo found convincing evidence supporting Copernicus' heliocentric theory.

Another remarkable scientist of the 1600's was Sir Isaac Newton of England. Newton used the findings of others to develop a unified view of the forces of the universe. In his book *Principia* (1687), he formulated a law of universal gravitation and showed that both objects on the earth and the heavenly bodies obey this law. Newton's studies of lenses and prisms laid the foundation for the modern study of optics. Newton and Gottfried Wilhelm Leibniz, a German philosopher, independently developed a new system of mathematics, calculus.

The scientific revolution also extended to many other

Dmitri Mendeleev published his periodic table of the elements.

1869

Marie and Pierre Curie isolated the element radium.

1898

Sigmund Freud established the field of psychoanalysis.

c. 1900

Wilhelm Wundt founded one of the first psychology laboratories.

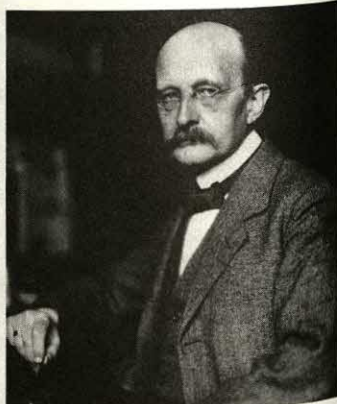
Paul Ehrlich originated the treatment of diseases with chemicals.



Gregor Mendel, an Austrian monk, discovered the basic laws of heredity in the mid-1800's. He studied the inheritance of various traits in garden pea plants.



Louis Pasteur of France started modern microbiology in the mid-1800's with his discovery that certain kinds of microscopic organisms cause disease.



Max Planck, a German physicist, advanced his quantum theory in 1900. The theory states that energy is given off in a stream of separate units called *quanta*.

areas of science. Modern physiology began in the early 1600's with the work of William Harvey, an English doctor. Harvey performed careful experiments and used simple mathematics to show how blood circulates through the human body. In the mid-1600's, an English scientist named Robert Hooke pioneered the use of the microscope to study the fine structures of plants and animals and uncovered a new world of cells. Also in the mid-1600's, Robert Boyle, an Irish scientist, helped establish the experimental method in chemistry. Boyle introduced many new ways of identifying the chemical composition of substances.

In addition to scientific discoveries, new ideas about the philosophy and methods of science arose during the 1600's. The French philosopher René Descartes proposed that mathematics was the model all other sciences should follow. He believed that mathematics yielded absolutely certain conclusions because the mathematical process started with simple, self-evident truths and then used logic to move, step by step, to other truths.

The English philosopher and statesman Francis Bacon viewed experience as the most important source of knowledge. He thought that by collecting all the observable facts of nature, a person could discover the laws which govern the universe. In his book *The New Atlantis* (1627), Bacon described a research institution equipped with many tools of modern science, including laboratories, libraries, and printing presses. Bacon's ideas inspired the creation of the Royal Society in London in 1660 and of the Academy of Sciences in Paris in 1666. These societies were among the first institutions whose chief aim was to promote science.

Some theologians of the 1600's supported science because they believed that it helped reveal the wonders of God's creation. They also felt that scientific discoveries could be used to improve the quality of human life. But many other theologians were deeply upset by the development of scientific laws that seemed to govern the physical world without divine assistance. They opposed the heliocentric theory and condemned other scientific ideas that they believed contradicted traditional beliefs about human beings and their place in the universe.

The Age of Reason, also called the *Enlightenment*, was a philosophical movement that greatly affected the development of science during the late 1600's and the 1700's. The leaders of the movement insisted that the use of reason was the best way to determine truth. They felt that everything in the universe behaved according to a few simple laws, which could be expressed mathematically. The philosophers of the Age of Reason developed many rules of scientific study that are still used.

Great efforts were made during the Age of Reason to circulate the results of the scientific research of the times. Many scholars gathered, organized, and published this knowledge. The most famous reference work was the 28-volume *Encyclopédie* (1751-1772) edited by two French authors, Denis Diderot and Jean d'Alembert. The *Encyclopédie* contained reports on much of the science and technology of the day. See **Age of Reason**.

One of the major scientific achievements of the 1700's was the creation of modern chemistry. Scientists developed the techniques necessary for isolating and studying gases in their pure forms. They discovered many chemical substances, including chlorine, hydrogen, and

Ernest Rutherford put forth his theory of atomic structure.

Jonas Salk produced the first effective polio vaccine.

1911

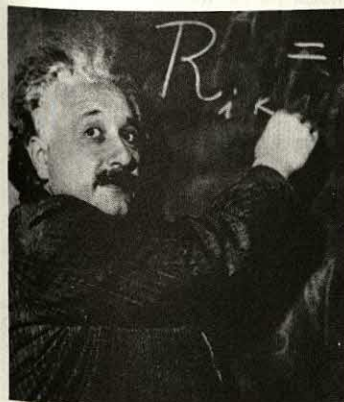
1928

1953

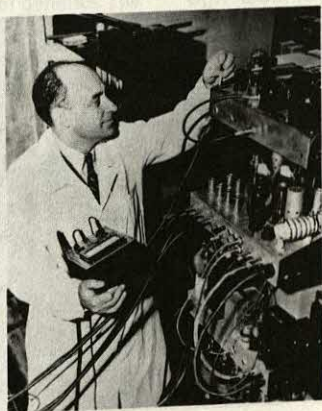
1957

Alexander Fleming discovered penicillin, the first antibiotic.

The Soviet Union launched the first artificial satellite.



Albert Einstein, a German-born physicist, revolutionized scientific thinking about space and time with his special theory of relativity, published in 1905.



Enrico Fermi and others at the University of Chicago achieved the first controlled nuclear chain reaction in 1942, starting the atomic age.



A ladderlike model of DNA, the substance that controls heredity, was built by James Watson of the United States, *left*, and Francis Crick of England, *right*, in 1953.

carbon dioxide. Oxygen was discovered by the Swedish chemist Carl Scheele in the early 1770's and independently by the English chemist Joseph Priestley in 1774. By 1777, Antoine Lavoisier of France had discovered the nature of *combustion* (burning). He showed that combustion results from the rapid union of the burning material with oxygen. Lavoisier also proved the law of the conservation of matter. This law states that matter cannot be created or destroyed but only chemically changed in form. Lavoisier also helped work out the present-day system of chemical names.

Major advances occurred in biology during the 1700's. A Swedish naturalist and botanist named Carolus Linnaeus devised a systematic method for naming and classifying plants and animals in the mid-1700's. His method, with many alterations, is still used. Two French naturalists, Comte de Buffon and Georges Cuvier made great advances in the study of fossils and of comparative anatomy and did much to prepare the way for the scientific investigation of evolution.

In 1776, the Scottish economist Adam Smith published *The Wealth of Nations*, the first systematic formulation of classical economics. The first systematic studies of electricity were also conducted during the 1700's. In the American Colonies, Benjamin Franklin proved in 1752 that lightning is electricity when he performed his famous experiment of flying a kite during a thunderstorm. In the late 1700's, two Italian scientists, Luigi Galvani and Count Alessandro Volta, made some of the first experiments with electric current.

Scientific advances of the 1800's. Scientific expeditions travelled to all parts of the world during the 1800's.

Their purpose was to expand geographical knowledge and to study the plants and animals they found. From 1831 to 1836, Charles Darwin worked as a naturalist with a British expedition aboard H.M.S. *Beagle*. The *Beagle* visited places throughout the world, and Darwin studied plants and animals everywhere it went. While on the voyage, Darwin read the works of a British geologist named Charles Lyell. Lyell believed that the earth had been changed slowly and gradually by natural processes over long periods of time. Darwin began to wonder whether life on the earth had also evolved through natural processes.

Darwin set forth his theories of evolution in *The Origin of Species* (1859). In this book, Darwin gave evidence that plants and animals had changed their characteristics through the ages. He explained how these changes might have occurred through *natural selection*. In this process, the organisms best suited to their environment are the ones most likely to survive and leave descendants. Darwin's ideas helped explain the basic similarities—or unity—among all living organisms because they evolved from common ancestors. The theory of evolution became one of the most intensely debated scientific issues of the late 1800's. The theory aroused especially fiery opposition among religious leaders who believed that it conflicted with the Biblical account of the Creation. See **Evolution**.

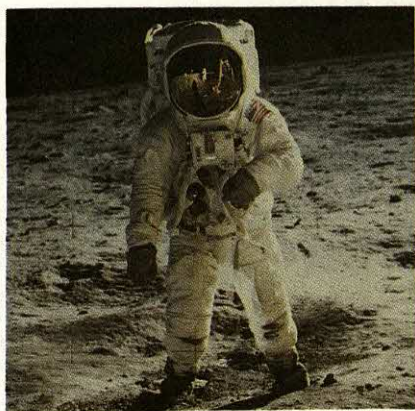
Another important unifying idea in the biological sciences was the theory that all living things are made up of cells. The theory was proposed by two German scientists, Matthias Schleiden and Theodor Schwann, in the 1830's. Their idea had been influenced by a German

Researchers developed the first successful recombinant DNA procedure.

1974

1981

The United States launched the *Columbia*, the first reusable manned spacecraft.



Space exploration began to open new frontiers of scientific research during the 1960's. In 1969, astronauts of the U.S. Apollo 11 mission became the first human beings to walk on the moon.



Tracks made by atomic particles from a *particle accelerator*, a device that speeds up the particles, enable physicists to study the most basic units of matter.



Genetic engineering, which is used to alter an organism's genetic makeup, may one day help in treating hereditary diseases.

philosophical movement called *Naturphilosophie*. This movement emphasized the unity of all things in nature and of all forces in the universe.

Physical scientists of the 1800's also tried to produce a unified, complete view of the laws of nature. The Russian chemist Dmitri Mendeleev helped systematize the study of chemistry when he published his periodic table in 1869. In the 1840's, James Joule, an English physicist, showed that heat is a form of energy. He was also one of several scientists to advance the law of the conservation of energy. This law states that energy cannot be created or destroyed but only changed in form.

The physicists Michael Faraday of England and Joseph Henry of the United States found independently in 1831 that a moving magnet can produce an electric current. In the 1860's, James Clerk Maxwell, a Scottish mathematician and physicist, worked out the mathematical equations for the laws of electricity and magnetism. Maxwell's electromagnetic theory stated that visible light consists of waves of electric and magnetic forces. It also proposed the existence of invisible waves composed of the same forces. In the late 1880's, Heinrich Hertz, a German physicist, produced electromagnetic waves that fitted Maxwell's theory. His work led to the development of radio, radar, and television.

During the late 1800's, several important scientific discoveries began to reveal a new picture of the physical universe. In the 1700's, the idea that matter consists of small particles that cannot be divided began to gain acceptance. In 1803, an English chemist named John Dalton had used the idea of indivisible particles, or atoms, to explain the way elements combine and form compounds. But in the 1890's, the picture of atoms as solid objects began to fade. Scientists discovered electrons and natural radioactivity. These discoveries suggested that atoms have some kind of internal structure.

Several new sciences had their beginnings in the 1800's. In the 1830's, the French philosopher Auguste Comte started the study of sociology. Comte developed the theory of *positivism*, which held that social behaviour and events could be observed and measured scientifically. In the mid-1800's, Gregor Mendel, an Austrian monk, discovered the basic statistical laws of heredity that laid the foundation for the science of genetics. The French chemist Louis Pasteur started modern microbiology in the mid-1800's with his studies of fermentation and disease. He found that certain microscopic organisms can produce disease in people and other animals.

Many scientists of the 1800's studied the relationship between the physiology of the nervous system and human behaviour. In 1879, Wilhelm Wundt, a German philosopher, founded one of the first laboratories of experimental psychology in Leipzig, Germany. In the late 1800's and early 1900's, the Austrian doctor Sigmund Freud established the field of psychoanalysis by introducing the idea that mental illness could be understood in terms of competing, unbalanced forces in the unconscious mind.

Science in the early 1900's. Revolutionary advances in physics marked the beginning of the 1900's. In 1900, Max Planck, a German physicist, advanced his quantum theory to explain the spectrum of light emitted by certain heated objects (see **Quantum mechanics**). The theory states that energy is not given off continuously, but

only in separate units called *quanta*. In 1905, another German physicist, Albert Einstein, showed that light may be regarded as consisting of individual energy units. He later suggested that these units were particles. They are now called *photons*. Also in 1905, Einstein published his special theory of relativity. His theory revised many of the ideas of Newtonian physics and offered scientists new ways of thinking about space and time. See **Relativity**.

Research into the structure of the atom expanded rapidly. In 1911, the British physicist Ernest Rutherford theorized that the mass of an atom is concentrated in a tiny nucleus, which is surrounded by electrons travelling at tremendous speeds. But his theory did not deal with the arrangement of electrons. In 1913, a description of electron structure was proposed by Niels Bohr, a Danish physicist. Bohr suggested that electrons could travel only in a set of definite orbits around the nucleus.

Bohr's original picture of the atom soon proved to be inadequate, though many of the ideas behind it were correct. By 1928, a complete description of the arrangement of electrons had been obtained with the help of other physicists, especially Erwin Schrödinger and Wolfgang Pauli of Austria, Paul Dirac of England, and Max Born and Werner Heisenberg of Germany. The discovery of the neutron and other atomic particles followed this early work. Chemists used the new information about atoms to improve their ideas about chemical bonds. They produced many new compounds and developed a variety of plastics and synthetic fibres.

Great progress was also made by social scientists of the early 1900's, as they began to rely more heavily on statistical analysis and scientific research methods. In the biological sciences, a number of researchers showed the importance of vitamins in the human diet. Their achievements helped conquer such nutritional diseases as beriberi and scurvy. The German doctor and chemist Paul Ehrlich founded the field of chemotherapy, in which diseases are treated with chemicals. In 1928, Alexander Fleming, a British bacteriologist, discovered penicillin, the first of many antibiotics.

The work of numerous scientists began to establish the importance of genetics as a separate branch of biology. About 1901, a Dutch scientist named Hugo de Vries extensively described *mutations*—changes in hereditary material of cells. About 1910, Thomas Hunt Morgan, an American biologist, and his associates proved that *genes* are the units of heredity and that genes are arranged in an exact order along the length of cell structures called *chromosomes*. Morgan mapped the location of genes on the chromosomes of fruit flies and identified the genes responsible for such specific traits as eye colour and wing shape. In the mid-1920's, an American geneticist named Hermann J. Muller discovered that mutations could be produced by treating an organism with X rays.

Achievements of the mid-1900's. Science continued to make great strides in all fields during the mid-1900's. One of the most important breakthroughs in nuclear physics occurred in the late 1930's, when Otto Hahn and Fritz Strassmann of Germany and Lise Meitner and Otto Frisch of Austria discovered the possibility of releasing energy by splitting atoms of uranium. The Italian-born physicist Enrico Fermi and his co-workers

achieved the first controlled nuclear chain reaction in 1942 at the University of Chicago. Intensive research during World War II (1939-1945) led to the use of nuclear energy in weapons.

Physicists discovered new elementary particles in the mid-1900's. They also established the existence of *antiparticles*, which have electric charges or other properties that are the reverse of ordinary atomic particles (see *Antimatter*). Chemists expanded the periodic table through the creation of new radioactive elements (see *Transuranium element*). Anthropologists made new discoveries about the distant past of human beings. Geologists explained many of the changes that occur in the earth's crust with their theory of *plate tectonics* (see *Tectonics*). Medical science developed the Salk and Sabin polio vaccines and introduced organ and tissue transplants and other new surgical techniques. Two biologists, James D. Watson of the United States and Francis H. C. Crick of Great Britain, proposed a model of the molecular structure of *deoxyribonucleic acid* (DNA), the substance that carries genetic information.

The space age began in 1957, when the Soviet Union launched the first artificial satellite to circle the earth. In 1969, two U.S. astronauts became the first human beings to walk on the moon (see *Space travel*). Astronomers also greatly expanded their knowledge of the size, structure, and history of the universe with the use of radio telescopes to collect and measure radio waves given off by objects in space. Using radio telescopes, astronomers discovered *pulsars*, *quasars*, and other previously unknown objects in space (see *Pulsar*; *Quasar*). Radio astronomers also found evidence to support the theory that the universe began with an explosion called the *big bang* (see *Cosmology* [The big bang theory]).

Science also made important contributions to technology during the mid-1900's. Physicists invented the transistor, which revolutionized the electronics industry and enabled manufacturers to produce portable battery-powered radios and TV sets, pocket-sized calculators, and high-speed computers. Similarly, the invention of *lasers* (devices that produce concentrated beams of light) promised great advances in communications, electronics, medicine, and weapons (see *Laser*).

Science of today and tomorrow. Scientific progress is faster today than ever before. This progress is reflected not only by the many discoveries made each year but also by the thousands of scientists involved in research and by the vast sums of money spent on scientific work. As the number of scientists has grown, cooperation and communication among them have become increasingly important. Many recent achievements have resulted from scientists working in research teams. Hundreds of scientific journals, professional societies, and computerized information systems make it possible for scientists throughout the world to exchange information quickly and easily.

Increasingly powerful and advanced equipment is helping scientists in many different fields expand our knowledge about the world. For example, *particle accelerators*, which speed up the movement of the particles that make up atoms, have enabled physicists to create and study *quarks* and other basic units of matter (see *Particle accelerator*; *Quark*). *Magnetic resonance imaging* and other advanced techniques produce images of

tissues inside the body and help to identify certain diseases and injuries (see *Magnetic resonance imaging*). Improvements in computers have enabled mathematicians to solve problems at previously unheard of speeds. New telescopes, satellites, orbiting observatories, and space probes have provided astronomers with information about distant reaches of the universe.

A process called *genetic engineering* has become a valuable tool in genetics research. In this process, an organism's hereditary makeup is altered. Geneticists have engineered bacteria to produce human *insulin*, a hormone used to treat diabetes, and human *interferon*, a protein that fights viral diseases. See *Genetic engineering*.

Scientists still have many new areas to explore. Through genetic engineering, for example, they hope to find new ways to diagnose and treat hereditary diseases. Astronomers are only beginning to investigate the idea of the *inflationary universe*—that is, the idea that the universe expanded extremely fast in the first fraction of a second following its origin in the big bang explosion. Physicists are working to develop *grand unified theories* that would explain the interactions between the elementary particles of atoms and the fundamental forces of the physical world.

The science of today and tomorrow promises to continue to improve our understanding of the universe and to give us ever greater control over nature. But at the same time, serious debates have arisen over such science-related issues as whether it is moral to interfere in the genetic makeup of human beings or to use lasers for destructive purposes. In the future, scientists and non-scientists alike will have an increasing responsibility to ensure that the best possible uses are made of knowledge from scientific research.

Related articles in *World Book* include:

Mathematics and logic

Algebra	Geometry	Probability
Calculus	Logic	Set theory
Econometrics	Mathematics	Statistics

The physical sciences

Acoustics	Electrochemistry	Optics
Aerodynamics	Electronics	Particle physics
Astronomy	Geochemistry	Physical chemistry
Chemistry	Geology	Physics
Cosmology	Geophysics	Radiochemistry
Cryogenics	Mechanics	Solid-state physics
Dynamics	Meteorology	Statics
Earth science	Nuclear physics	Thermodynamics

The life sciences

Anatomy	Ecology	Microbiology
Bacteriology	Embryology	Molecular biology
Biochemistry	Exobiology	Morphology
Biology	Genetic engineering	Nutrition
Biophysics	Genetics	Palaeontology
Botany	Gnotobiotics	Pharmacology
Classification	Histology	Physiology
Scientific	Marine biology	Sociobiology
Cryobiology	Medicine	Zoology
Cytology		

The social sciences

Anthropology	Geography
Archaeology	History
Criminology	Linguistics
Economics	Philosophy

Political science
Psychology

Social science
Sociology

Biographies

World Book has hundreds of biographies of scientists. For the titles of these biographies, see the lists of *Related articles* with specific articles on the major branches of science, such as **Biology** and **Physics**.

Other related articles

Research

Technology

Outline

I. The importance of science

- A. To everyday life B. To philosophical thought

II. The branches of science

- A. Mathematics and logic C. The life sciences
B. The physical sciences D. The social sciences

III. How scientists work

- A. Observing nature E. Forming a hypothesis
B. Classifying data F. Expressing findings mathematically
C. Using logic
D. Conducting experiments

IV. The history of science

Questions

- What is an *interdisciplinary* science?
What are some methods scientists use in making discoveries and developing theories?
Who was one of the first scientists to recognize that systematic experimentation could help reveal the laws of nature?
What are some ways in which modern science and technology have changed our lives?
Why are mathematics and logic essential tools in almost all scientific study?
What people preserved much of the science of ancient Greece and Rome during the Middle Ages?
What characteristics set science apart from other branches of knowledge?
How did the discovery of electrons and natural radioactivity begin to reveal a new picture of the physical universe?
What were the limitations of Greek science?
What marked the rebirth of science in Europe in 1543?

Science fiction is a popular kind of imaginative literature. Its basic themes include space travel, time travel, and marvelous discoveries or inventions. Most modern science-fiction stories are set in the future, but some take place in the past or even in the present day. Some are set in another universe. Unlike fantasy, which deals with the impossible, science fiction describes events that could actually occur, according to accepted or possible theories. Some stories give detailed scientific explanations. Others simply thrust the reader into a strange time or place.

Beginnings of science fiction go back to prehistoric myths and tales of fantastic voyages and adventures. In the A.D. 100's, the Greek writer Lucian of Samosata transformed these adventures into science fiction. For example, his *Icaromenippus* and *The True History* describe trips to the moon.

The 1600's brought the birth of both modern science and science fiction. Francis Bacon, often called the father of modern science, wrote *The New Atlantis* (1627). This work uses the theme of a marvellous voyage to describe a society based on experimental science and the practical wonders science could create. The German astronomer Johannes Kepler described a trip to the moon in his *Somnium* (published in 1634, after his death). This book was the first science fiction that tried to tell a story

with scientific accuracy. The 1600's also produced the first science fiction set in the future—Francis Cheynell's *Aulicus* (1644) and Jacques Guttin's *Epigone, Story of the Future Century* (1659).

As science fiction developed during the 1700's, it produced its first literary masterpiece, *Gulliver's Travels* (1726) by Jonathan Swift. Ludwig Holberg's *The Journey of Nils Klim to the World Underground* (1741) was a source of inspiration for Giovanni Casanova's *Icosameron* (1788). Both these works were forerunners to Jules Verne's *A Journey to the Centre of the Earth* (1874). The first story of visitors from other planets was Voltaire's *Micromégas* (1752).

The Industrial Revolution caused social revolution and hardship among many people. These elements influenced the Gothic novel, which featured horror, violence, and the supernatural. The chief science-fiction work in this field was Mary Shelley's *Frankenstein* (1818). Edgar Allan Poe and Nathaniel Hawthorne developed the science-fiction short story.

By the late 1800's, science fiction had reached its most characteristic modern form in the works of Verne and H. G. Wells. Verne was the first writer to specialize in science fiction. He made the general public aware of it as a distinct branch of literature.

The 1900's. Social and political argument, which appeared in much early science fiction, were emphasized even more in the 1900's. Eugene Zamiatin's *We* (1924), written during the Russian civil war, defined a form known as *anti-utopia*. Utopian fiction portrays ideal worlds. Anti-utopian fiction sees these ideal worlds as nightmares. Famous examples include Aldous Huxley's *Brave New World* (1932) and George Orwell's *1984* (1949). A widely read answer to anti-utopian fiction is *Andromeda* (1956), a utopian novel by Ivan Yefremov.

Science fiction predicted the technological and scientific marvels of the atomic and space ages. Karel Čapek coined the word *robot* in his play *R.U.R.* (1921) and discussed the atomic bomb in his novel *Krakatit* (1924). Olaf Stapledon wrote two influential science-fiction novels, *Last and First Men* (1931) and *Star Maker* (1937).

In Russia, science fiction began receiving much attention and encouragement as early as the 1920's. In 1928, the Russian author Maxim Gorki praised science fiction for displaying "the amazing ability of our thought to look far ahead of actual events."

In the United States, magazines called *pulps* played the major role in the development of science fiction. Hugo Gernsback founded the first pulp, *Amazing Stories*, in 1926. About 1930, he became the first person to use the term *science fiction*. The early pulp magazines concentrated on scientific marvels, but turned increasingly to major social concerns. Isaac Asimov, one of the most widely read science fiction writers, contributed to these magazines before publishing his first book, *A Pebble in the Sky*, in 1950.

Science fiction gained a wider audience after World War II ended in 1945. Its popularity grew as developments in nuclear energy and space exploration showed that much science fiction was more realistic than many people believed it to be.

During the 1960's and early 1970's, the role of magazines in science fiction diminished while books became more and more important. Science-fiction novels in hard

covers first were published in 1950 and steadily increased in number. Beginning in the 1960's, there was also a huge increase in science fiction published in paperback. Serious science-fiction programmes appeared on television in a number of countries. One of the best known of these was "Star Trek," which originally appeared on American television from 1966 to 1969 but gained its greatest popularity when it was rerun in the 1970's and again in the 1980's.

Science fiction today. In 1977, the science-fiction film *Star Wars*, which had impressive special effects, set box-office records. *Star Wars* was followed by two sequels, *The Empire Strikes Back* (1980) and *Return of the Jedi* (1983). Such science-fiction films as *Alien* (1979), *The Terminator* (1984), and *Terminator 2: Judgement Day* (1991) attracted large audiences. The science-fiction film *E.T.: The Extra-Terrestrial* (1982) told a charming tale about an appealing lost creature from another world who is befriended by earth children. Several films based on "Star Trek" were made.

During the mid-1970's, a new interest in magazine science fiction developed. The first successful new science-fiction magazine since 1950, *Isaac Asimov's Science Fiction Magazine*, began publication in 1977. In 1978, *Omni* became the first science magazine to publish science fiction regularly. In the 1970's and 1980's, a number of science-fiction authors gained popularity with general readers. The best known of these writers included Frank Herbert, Robert A. Heinlein, Arthur C. Clarke, and Ursula Le Guin.

Science fiction became enormously popular in Russia and Japan during the mid- and late 1900's. Some writers, including the brothers Arkady and Boris Strugatsky of Russia and Sakyo Komatsu of Japan, have achieved worldwide fame. Stanislaw Lem of Poland has been recognized as a major science fiction writer since the 1950's.

Related articles in World Book include:

Asimov, Isaac	Gulliver's Travels	Spielberg, Steven
Bradbury, Ray	Heinlein, Robert A.	Swift, Jonathan
Capek, Karel	Le Guin, Ursula	Utopia
Clarke, Arthur C.	Lucas, George	Verne, Jules
Frankenstein	Stapledon, Olaf	Wells, H. G.

Scientific classification. See Classification, Scientific.

Scientific creationism is the belief that most evidence indicates the world began through an act of creation. According to this belief, the earth and all forms of life, including human beings, were created essentially as they exist today. Most scientific creationists believe that the majority of the evidence supports a relatively recent date for the creation, perhaps thousands rather than millions or billions of years ago.

Scientific creationists reject the theories of chemical and organic evolution, which most scientists accept. The theory of chemical evolution states that life on earth arose as single-celled organisms about $3\frac{1}{2}$ billion years ago. According to the theory of organic evolution, life forms gradually increased in complexity and this process eventually produced all the species on earth.

Scientific creationists believe that it is scientifically improbable that life itself or complex organisms could have evolved through natural processes in keeping with scientific principles. Scientific creationists also maintain

that fossil evidence fails to show any one kind of organism in transition to any other kind of organism. Instead, the fossil record shows systematic gaps between various kinds of organisms.

See also **Evolution** (Acceptance of evolution).

Scientific method. See Science (How scientists work); **Research**; **Age of Reason**.

Scientology is a religious movement founded by L. Ron Hubbard (1911-1986), an American writer and thinker. His thought combined ideas from Eastern religion, and from modern psychoanalysis and philosophy to form a system for achieving mental health.

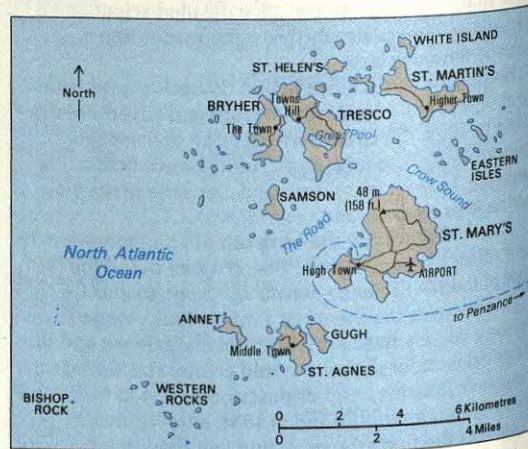
According to Scientology, every person is an immortal being who has been born over and over again. Although each soul has great powers, negative experiences in previous lifetimes have produced *engrams*, which are mental images that prevent the soul from using its vital force. Scientology *auditors* (leaders) try to guide people through a *clearing* process that erases engrams and allows the soul to realize its potential. As people rise through several levels of knowledge, they become *thetans*, those who fully grasp the divine force that is their fundamental nature. The goal of Scientology is to restore people to their infinite potential.

The first Scientology church was established in California in 1954. As Scientology spread during the 1960's, it received much criticism. For example, various medical organizations claimed that Scientologists practised medicine disguised as religion. However, in spite of long and highly publicized controversies, including charges of financial embezzlement, this spiritual movement has attracted followers throughout the world.

Scilly, Isles of (pop. 2,900), lie in the Atlantic Ocean off the English coast, about 40 kilometres west of Land's End, Cornwall. This group of approximately 150 islands

Isles of Scilly

- Main road
- - - Ferry
- Town or settlement
- ▲ Elevation above sea level





Hugh Town, on the island of St. Mary's, is the administrative capital of the Isles of Scilly. It is also the commercial centre of the islands.

has a total area of about 14.5 square kilometres. Only five of the islands are inhabited.

Local government. The Isles of Scilly are part of England. They are administered by a council, with the powers of both a county and a district council. The Scillonian council, with offices at Hugh Town, on St. Mary's, deals with local planning, highways, social services, and the fire service. Cornwall County Council administers the other services. The Devon and Cornwall Police Authority provides police service for the Isles of Scilly.

Economy. Flower growing, favoured by warm summers and mild winters, is the main feature of the islands' economy. Many people also specialize in growing early potatoes and broccoli. Other industries are tourism, and lobster and crab fishing.

The inhabited islands. St. Mary's, the largest island, has a small museum devoted to Scillonian history and natural history. Treco, the second largest island, has bleak and wild scenery in the north, while its southern side is lush and tropical. Treco Abbey is surrounded by colourful gardens. St. Martin's, the third largest island, has beautiful beaches. Bryher is a small island with imposing cliffs on its north coast. St. Agnes is a tiny remote island reached by boat from St. Mary's. The Isles of Scilly form an area of outstanding natural beauty. Helicopter and steamer services operate to Scilly from Penzance, in Cornwall.

History. People have lived on the Isles of Scilly since Bronze Age times. Tin mining began during the Roman period and lasted until 1878. In the 1100's, Benedictine monks set up a priory on Treco. Up to the 1400's, the islands suffered frequent pirate raids. In the late 1500's, they were fortified against the Spaniards.

Life was hard for the Scillonians up to the 1800's. Augustus Smith, who became lord proprietor of the Isles of Scilly in 1834, brought improvements in education to the islands. Then, with the introduction of the flower industry to the islands, the Scillonians began to achieve some prosperity.

Scintillation counter. See **Radiation** (Scintillation counters).

Sciortino, Antonio (1879-1947), a Maltese sculptor, conceived the idea of building a monument to the unknown soldier shortly after World War I ended in 1918. His works, in terracotta, marble, and bronze, include portraiture and allegory. A typical example of his work is the sculpture entitled *Arab Horses* (1930), a plaster cast. He produced a number of monuments in bronze for Malta, including the impressive *Christ the King*. Other works include an equestrian monument of the Venezuelan general Simón Bolívar, and memorials to the Ukrainian patriot Taras Shevchenko and the Russian writer Anton Chekhov. Critics praised Sciortino's art for the way it expressed speed and movement.

Sciortino was born in Malta. He studied engineering and monumental architecture in Rome. He set up a studio in Rome, where he met his lifelong friend the French sculptor Auguste Rodin. From 1902 to 1927, he was director of the British Academy of Arts in Rome.

Scipio Africanus, Publius Cornelius (236?-183? B.C.), was a Roman general who defeated the great Carthaginian general Hannibal in the Second Punic War (218-201 B.C.). The decisive battle took place at Zama, in northern Africa, and the Romans gave Scipio the name *Africanus* because of his victory. He was also called Scipio the Elder. See **Hannibal**.

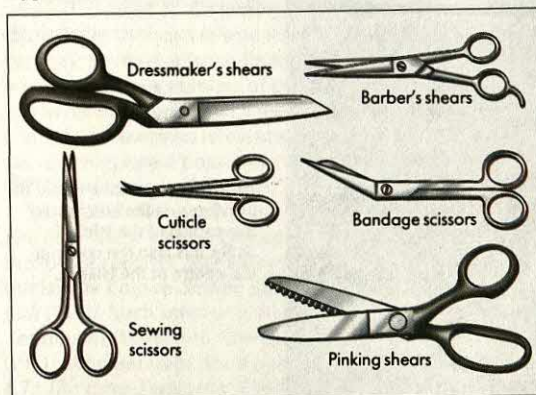
Scipio belonged to a wealthy and politically powerful family in Rome known as the Cornelii. In 199 B.C., he was elected a *censor*, an official who supervised the census and public morals. In 184 B.C., while running for censor again, Scipio was accused of bribery. Facing possible disgrace, he retired from public life.

Scissorbill. See **Skimmer**.

Scissors. A pair of scissors is really two knife blades joined together to form a double lever. Each blade operates as a lever of the first class (see **Lever**). A pin or bolt holds the blades together and acts as their common fulcrum. The user squeezes the open scissors handles together and thus applies pressure against both sides of the material, which is cut.

To most people, scissors and shears refer to the same instrument. But, in the hardware trade, *shears* refers to

Types of scissors



scissors with blades more than 15 centimetres long. The handles of scissors usually have rings of equal size. Most shears have a larger ring on one handle for the four fingers of the cutting hand. The thumb of the cutting hand fits through the other ring. Scissors and shears range in size from tiny manicuring scissors to giant, power-operated shears that cut scrap metal to size for steel-mill furnaces. *Pinking shears*, or *pinking scissors*, have saw-tooth edges. They give cloth a scalloped edge that keeps the material from ravelling.

Scissors developed shortly after people learned how to make knives. Sharp, sturdy scissors were developed in the late 1200s.

Sclerosis, Multiple. See Multiple sclerosis.

Scofield, Paul (1922-), is a British actor who has achieved success, mainly in the classics, in London and New York City. His most notable roles include Sir Thomas More in Robert Bolt's play *A Man for All Seasons*, and a superb portrayal of the title role in Shakespeare's *King Lear*.

Scofield was born in Hurstpierpoint, in West Sussex. He studied drama at the Croydon Repertory School and at the London Mask Theatre School.

From 1966 to 1968, Scofield was a director of the Royal Shakespeare Company.

Scoliosis is a side-to-side curve of the spine. In most cases, this condition becomes apparent during adolescence or even earlier. It affects more girls than boys, but doctors do not know why. Advanced cases can result in severe deformity that may interfere with the heart, lungs, and nervous system. Such deformity can also lead to psychological problems. Doctors do not know what causes most cases, though some result from muscular diseases or birth defects.

Many people have some form of scoliosis, but only a small percentage need medical treatment. Mild cases are simply examined regularly to make sure they do not become worse. Orthopaedic surgeons generally prescribe a back brace and special exercises to stabilize a

moderate spinal curve in young people who have not completed their skeletal growth. During the early 1980s, many doctors began experimenting with electrical stimulation instead of braces to stabilize moderate curves. In this procedure, a small electrical transmitter is attached nightly to electrodes taped on the surface of the patient's back or surgically implanted under the skin. The transmitter stimulates the deep back muscles and causes them to contract, pulling the spine into line.

Severe scoliosis may require surgery to straighten and *fuse* (join) the vertebrae in the area of the curve. In many cases, a steel rod is permanently attached to the spine. A body cast is worn for several months, after which most normal activities can be resumed.

In most cases, early detection and treatment of scoliosis eliminate the need for surgery. In some countries students between 10 and 15 years old are tested for symptoms of scoliosis. The symptoms include hips or shoulders that are not level, a prominent shoulder blade, or a hump on the back.

Scone, Stone of, is a stone on which the kings and queens of Great Britain are crowned. It lies beneath a special coronation chair in Westminster Abbey. It is also called the *Stone of Destiny*. King Edward I took the stone from Scotland and brought it to England in 1296. For hundreds of years before that, the kings of Scotland had been crowned on the stone. Scottish nationalists repossessed the stone in 1950, but it was recovered and returned to Westminster Abbey. See also *Westminster Abbey* (picture).

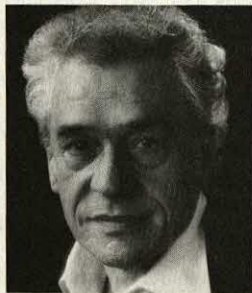
Scooter. See *Motorcycle*.

Scopes trial was one of the most famous and controversial legal cases in United States history. The trial involved a school teacher named John Thomas Scopes, and it took place in Dayton, Tennessee, in 1925. Scopes was found guilty of violating a Tennessee law that made it illegal to teach the theory of *evolution* in public schools. This theory suggests that human beings developed from simpler forms of life over a long period of time. By law, teachers in state schools were allowed to teach only the Biblical account of the Creation, which tells how God created human beings essentially as they exist today. Many scientists accepted the view that monkeys and humans had common ancestors, and so the Scopes case was often called the "monkey trial."

The trial attracted worldwide attention, largely because of the participation of two celebrities, William Jennings Bryan and Clarence Darrow. Bryan, an unsuccessful candidate for President of the United States three times, aided the prosecution. He believed in *fundamentalism*, a movement whose members insist that words of the Bible should be taken literally. Darrow, a famous criminal lawyer, defended Scopes. Darrow strongly supported the right to teach evolution. Bryan, considered an expert on the Bible, accepted Darrow's challenge to become a witness. But Darrow humiliated and outsmarted Bryan in the cross-examination.

Legally, the Scopes case was unimportant. Scopes was fined 100 U.S. dollars, but the conviction was later reversed because of a small legal error. The Tennessee law remained in effect until 1967, when the state legislature abolished it.

See also *Bryan* (William Jennings); *Darrow, Clarence Seward*.



Paul Scofield



Scorpio is a group of stars that form the eighth sign of the zodiac. This illustration is from *Uranographia* by Johann E. Bode, published in 1801.

Scorpio, the *Scorpion*, is a constellation (group of stars) that can be seen in both the Northern and Southern hemispheres. It is the eighth sign of the zodiac and it is one of the most brilliant constellations in the heavens. In mythology, Scorpio represents the insect that caused the untimely death of Orion. The constellation is made up of a long line of bright stars that resembles the outline of a scorpion. It has a red heart, distinguished by the bright, red giant star Antares. The sting is marked by the star Lambda Scorpii, which is also known as Shaula, a name that comes from the Arabic word for "sting". The constellation contains Iota, a star with a luminosity about 200,000 times as great as the sun. Scorpio shows against the background of the Milky Way and contains some spectacular star clusters. These include M4 (near Antares), an object that can easily be distinguished with binoculars, and M6 and M7, both visible with the naked eye. The sun passes briefly through the constellation during the last week of November.

See also **Astrology**; **Astronomy**; **Zodiac**.

Scorpion is a small animal with a potentially dangerous poisonous sting in its tail. The scorpion is not an insect. It belongs to a class of animals called *arachnids*. Spiders, mites, and ticks also belong to this class. Scorpions live in warm countries in most parts of the world.



The scorpion has a poisonous sting in its tail.

A scorpion's body has two parts. Its short and thick forward part, called the *cephalothorax*, consists of the head and *thorax* (chest), which are joined together. The hind part is the long abdomen. Its last six segments form a slender tail. Most scorpions are black or yellowish and from 1 to 20 centimetres long.

The scorpion has six pairs of jointed appendages. The first pair consists of tiny pincers. The second pair, with large claws, is used to seize and crush prey. The last four pairs are legs. There are 6 to 12 eyes—different kinds of scorpions have different numbers.

Scorpions eat insects, spiders, and other scorpions. They are most active at night. Scorpions are fluorescent when exposed to ultraviolet light and are easy to spot at night by using a black light. The scorpion's sting is a curved organ at the end of its tail. Two glands at the base give out a poison that flows from two pores. It is used for defence or to kill prey. A scorpion wound is painful, but rarely causes death in human beings.

Scientific classification. Scorpions belong to the class Arachnida, order Scorpiones. The families of scorpions include Buthidae and Chactidae.

Scorpion fly is an unusual insect that often has a long, pointed face. At the tip of the abdomen, the male has an enlarged body segment that curves up over the back. This segment resembles a scorpion's stinging mechanism and gives the insect its name.



Scorpion flies are not true flies. They are named after scorpions because of the way their abdomen bends over at the tip.

The scorpion fly is about 20 millimetres long. Its mouthparts are at the end of its face. It is not a true fly because it has four wings instead of two. The wings have many veins and are as long as the body. Adult scorpion flies live in woods or dense plant growth and eat chiefly insects. They lay eggs in cracks in the ground. The larvae, which resemble caterpillars, hatch in about a week. They live on or in the soil and feed on insects.

Scientific classification. Scorpion flies make up the scorpion fly family, Panorpidae. A common scorpion fly is *Panorpa nebulosa*.



The rugged Highlands cover the northern two-thirds of Scotland. Blue lakes and steep valleys make the Highlands one of the most scenic areas in Europe.

Scotland is one of the four major political divisions that make up the United Kingdom of Great Britain and Northern Ireland. The other divisions are England, Northern Ireland, and Wales. Edinburgh is the capital of Scotland, and Glasgow is the largest city.

Scotland occupies the northern third of the island of Great Britain. Most of Scotland is mountainous. Its rugged mountains, green valleys, and deep, blue lakes provide some of the most beautiful scenery to be found in Europe.

Most of the Scottish people live in the central part of Scotland, where the land is flatter and more fertile. Many Scots work in the service and manufacturing industries, which form the basis of the economy in Scotland.

The Scottish people have long been famous for their close-knit *clans* (groups of related families), colourful plaid kilts, and skill as fierce warriors. But the clans have lost much of their importance, kilts are worn mainly for

ceremonial occasions, and no war has been fought in Scotland for more than 200 years.

This article tells about the people, geography, and economy of Scotland. For a discussion of the United Kingdom as a whole, and Scotland's relation to the other divisions of the United Kingdom, see the *World Book* article **United Kingdom**. For an account of Scotland's history up to 1746, see **Scotland, History of**. For an account of the history of Scotland after 1746, when the last Scottish revolt was crushed and the history of Scotland became part of that of the UK, see **United Kingdom, History of the**.

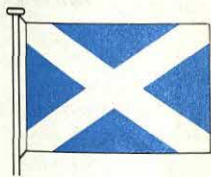
Government

The United Kingdom is a constitutional monarchy. The British monarch is the head of state, but a cabinet of government officials called *ministers* actually governs the United Kingdom. The *prime minister* is the chief official. Parliament makes the laws. Parliament includes

the monarch, the House of Commons, and the House of Lords. Members of the House of Commons are elected from England, Northern Ireland, Scotland, and Wales. Scotland elects 72 of the 651 members of the Commons. The Lords has limited power. Most of its members are nobles who inherit their seats. For more information on the British government, see **United Kingdom, Government of the**.

The Scottish Office. Scotland's chief minister is the *secretary of state for Scotland*. This official is appointed by the prime minister of the United Kingdom and is a member of the Cabinet.

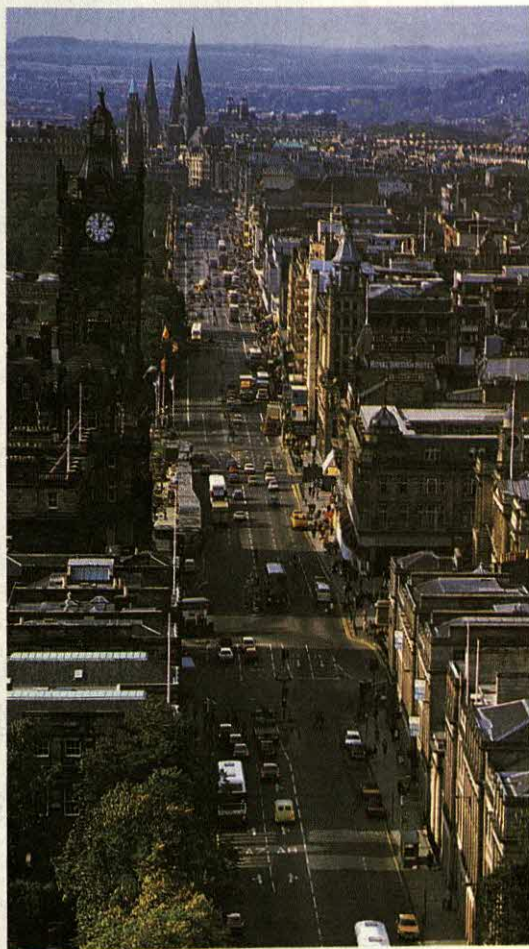
The secretary's office, called the Scottish Office, is based in Edinburgh, with an additional office in London. The Scottish Office has five main departments. The Scottish Office Agriculture and Fisheries Department deals with Scotland's agricultural and fishing industries. The Scottish Office Industry Department deals with industrial and economic development. The Scottish Office Environment Department is concerned with such fields as environmental protection, housing, and public utilities. The Scottish Office Education Department supervises public education. The Scottish Office Home and Health Department is responsible for criminal justice, police and fire protection, prisons, and public health. Each department of the Scottish Office is run by a secretary.



Scotland's flag is called *St. Andrew's Cross*. The flag has never been officially adopted, but the Scottish people have flown it for hundreds of years.



Scotland's version of the **Royal British Arms** includes the arms of Scotland, England, and Ireland.



Edinburgh is the capital of Scotland. The city's Princes Street, *above*, is one of the world's most beautiful thoroughfares, lined with fashionable shops, hotels, and art galleries.

Facts in brief about Scotland

Capital: Edinburgh.

Official language: English.

Form of government: Constitutional monarchy; part of the United Kingdom of Great Britain and Northern Ireland (see **United Kingdom, Government of the**).

Area: 78,789 km². *Greatest distances*—north-south, 441 km; east-west, 248 km. *Coastline*—about 3,700 km.

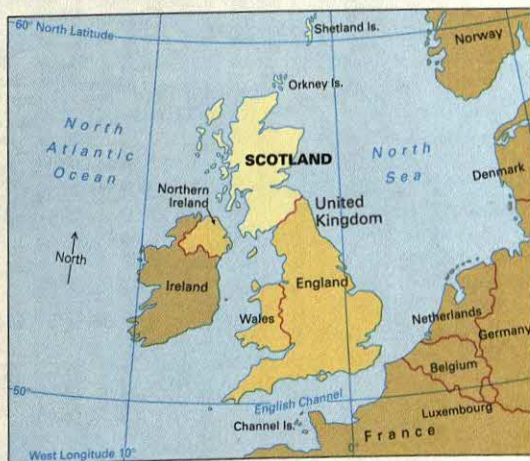
Elevation: *Highest*—Ben Nevis, 1,343 m above sea level.

Lowest—sea level along the coast.

Population: *Estimated 1996 population*—5,146,000; *1991 census*—4,999,000; density, 64 people per km²; distribution, 86 per cent urban, 14 per cent rural. *Estimated 2001 population*—5,143,000.








Chief products: *Agriculture*—barley, cattle, milk, sheep, wheat. *Fishing*—cod, haddock, mackerel. *Manufacturing*—foods and beverages, electronic equipment, chemicals, industrial machinery, paper and textiles. *Mining*—petroleum.

Money: *Currency unit*—pound. One pound = 100 pence. See also **Pound**.



Scotland covers about a third of the island of Great Britain. England and Wales are also on the island.

E

-  National boundary
-  Region boundary
-  Motorway or road
-  Railway
-  National capital
-  Administrative centre
-  Other city or town





Bagpipes and kilts have been well-known symbols of Scotland for hundreds of years. Bagpipe bands in traditional Highland costumes are popular features at many Scottish events.

come an independent country within the European Union, an economic organization of European nations. Many others believe that Scotland should have its own legislative assembly while remaining a part of the United Kingdom. The Scottish National Party favours independence. The Labour Party and the Liberal Democrats, which represent more than three-quarters of the Scottish members of Parliament, favour devolution within the United Kingdom. The Conservative Party opposes independence or a large degree of devolution.

People

Population. Scotland has a population of about 5 million. About three-quarters of the people live in the lowlands of central Scotland, a region that makes up only about a sixth of Scotland's mainland. The rugged Highlands and the hilly uplands of southern Scotland are more sparsely populated. The Highlands, which cover about two-thirds of the Scottish mainland, have some of the most thinly populated areas in Scotland. Less than 2 per cent of the people live in Scotland's three island authority areas of Orkney, Shetland, and the Western Isles.

One of Scotland's major problems has been emigration. Particularly in the 1960's, thousands of people left Scotland because of limited job opportunities. But new industries, such as the production of oil from the North Sea, have helped provide more jobs.

Ancestry. Most Scottish people are descended from peoples who came to Scotland thousands of years ago. These groups included the Celts, Scandinavians, and a Celtic tribe from Ireland called the Scots. Each group influenced Scottish civilization.

Language. English is the official language throughout the United Kingdom. In Scotland, English is spoken in a variety of dialects.

About 80,000 Scots speak *Gaelic*, an ancient Celtic language. Most of these people live in the Highlands or on the islands west of the mainland. See **Gaelic language**.

Way of life

Industrialization has eliminated many of Scotland's old traditions and ways of life. Many fortified castles still stand in Scotland, remnants of its warlike past. But day-to-day living in Scotland is becoming more like that in other parts of the United Kingdom and Europe. Today, most Scots are wage earners who live in or near cities.

City life. More than three-quarters of Scotland's people live in towns and cities. A handful of the cities have populations of more than 100,000. Glasgow, Scotland's largest city, has about 650,000 people. About 420,000 people live in Edinburgh, the capital. Aberdeen has a population of about 201,000 and Dundee about 165,000. See the cities of Scotland listed in the *Related articles* at the end of this article.

Small homes, terrace houses, and apartment buildings made of stone are common in Scotland's cities. Many Scottish cities developed around coal mining and heavy industry during the 1800's and early 1900's. Much of the housing then was of poor quality. But after World War II ended in 1945, the government began extensive efforts to improve living conditions in Scotland. It replaced much of the housing with modern, government-owned dwellings. The district councils and island authority councils own the government dwellings, which are called *council houses*. By the 1990's, privately owned housing was becoming more popular than government-owned housing in Scotland.

Crowding and pollution are rare in Scottish cities, partly because Scotland's heavy industry has declined. Glasgow ranked as a great industrial and commercial centre in the late 1800's and early 1900's. It was known as the Second City of the British Empire, London being the first city. Five new towns, including East Kilbride and Cumbernauld, were built in the Central Lowlands to ease crowding in Glasgow. Although much heavy industry closed in the mid-1900's, new industries in light manufacturing and other fields have developed, keeping Glasgow and the Central Lowlands the industrial centre.

of Scotland. But some towns in the area still face high unemployment rates.

Unlike the people in Glasgow, people in Aberdeen have seen great growth and prosperity since the 1970's. This growth is mostly due to the opening of offshore oil and gas fields under the North Sea. The fields provide many jobs and bring much money to the area. They have made Aberdeen the oil capital of Europe.

Rural life. Less than one-quarter of Scotland's people live in rural areas. Much of Scotland's countryside has rugged terrain and offers only a limited number of jobs and resources. Some rural workers fish, grow crops, raise livestock, or harvest timber. However, only about 2 per cent of Scotland's employed people earn their living in farming, fishing, and forestry. As a result, many rural dwellers work in the cities.

The distinction between urban and rural communities in Scotland is often blurred. As a result of better transportation and greater contact with the cities, rural communities have become less distinctive and their people less close-knit. As in the cities, housing in rural areas greatly improved during the late 1900's. Fewer rural people live in apartments, but otherwise housing and social conditions in urban and rural areas are similar.

Food and drink. Favourite foods and beverages in Scotland increasingly resemble those in other parts of the United Kingdom. Most Scottish cooking is simple. Favourite traditional Scottish dishes include fish and chips, herring, roast beef, and roast lamb. The Scots also enjoy fine steaks from Scotland's famous Aberdeen-Angus cattle.

Other traditional Scottish foods include haggis, kippers, oatmeal, and salmon. *Haggis* is a famous national

dish made from the heart, liver, and lungs of a sheep. These ingredients are chopped with *suat* (animal fat), onions, oatmeal, and seasonings, and then boiled in a bag made from a sheep's stomach. *Kippers* are smoked herring, a traditional breakfast dish. Oatmeal is used in many Scottish dishes, including porridge and *oatcakes* (flat cakes cooked on a griddle), both of which are popular for breakfast. Salmon is served smoked, grilled, or poached. Salmon taken from Scottish waters is considered one of the world's tastiest fishes.

In addition to traditional Scottish foods, other foods such as hamburgers, pizzas, and *curries* (stews spiced with curry) are popular in Scotland. Tea is also popular. The number of Scots who drink coffee has increased greatly since the mid-1900's.

One of the favourite alcoholic drinks in Scotland is Scotch whisky, or Scotch. The Scots have been making whisky since the 1400's. They export about 322 million litres of Scotch yearly.

Recreation. Most Scots enjoy sports and outdoor activities. Scotland's huge open lands make excellent recreational areas.

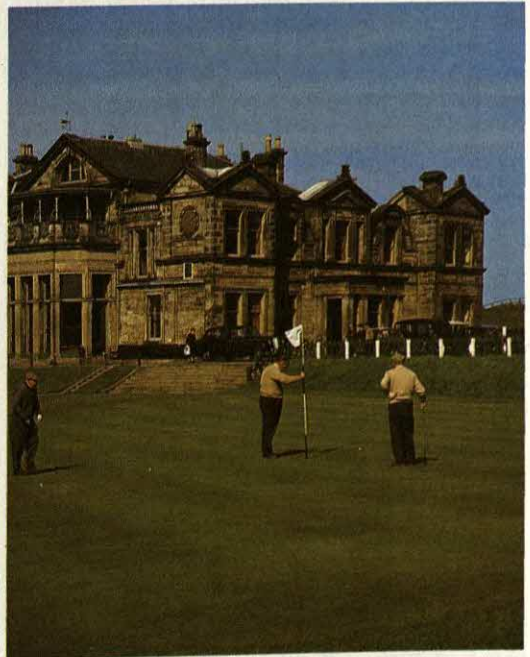
The Scots probably developed the modern game of golf, and it is still one of their favourite games. Scotland's numerous golf courses include the world-famous Royal and Ancient Golf Club of St. Andrews. See **Golf** (History).

Scotland's most popular organized sport is *association football*, or soccer. Thirty-eight professional teams play in the Scottish Football League and leading teams play in European competitions. Rugby football is also popular in Scotland.

The Highland Games, which resemble athletic meet-



Sheep shearing is an important activity in many Highland communities. These skilled shearers are using hand clippers to remove the wool. The Highlands are well suited for raising sheep.



The Royal and Ancient Golf Club of St. Andrews, one of the world's most famous golf courses, lies near the North Sea. The modern game of golf probably developed in Scotland.



Forth bridges carry road and rail traffic over the Firth of Forth. The road bridge, in the foreground, was completed in 1964. The rail bridge was completed in the 1880's.

ings, are held throughout the Highlands during the spring, summer, and early autumn. Field events include tossing the *caber*, a long wooden pole that weighs about 82 kilograms. Athletes compete to see who can heave the caber the straightest. Other events of the Highland Games include footraces and dancing and bagpipe competitions. The British royal family traditionally attends the games held in Braemar.

People from throughout the world come to fish for trout and salmon in the clear mountain streams of the Highlands. Hiking, mountain climbing, and shooting are also popular in the Highlands. The area around Ben Nevis in western Scotland is one of the best mountain-climbing regions in Europe.

Popular winter sports in Scotland include skiing and



Skiing is popular in winter in Scotland. Aviemore, in Highland Region, is the main skiing centre.

curling. *Curling* is a game in which the players slide heavy stones across a sheet of ice toward a target.

Education. Scotland's system of education is separate from that of England and Wales and from that of Northern Ireland. The Scottish Office Education Department and local education authorities supervise the school system in Scotland.

All Scottish children between the ages of 5 and 16 must attend school. Nearly all schools are supported by public funds. Scotland has few private schools, most of which are in Edinburgh.

For many years, Scotland had separate schools for vocational and academic education. But during the 1970's, these specialized schools were replaced with *comprehensive schools*. Comprehensive schools provide both types of education, and students take courses geared to their abilities.

Scotland has 12 universities—Aberdeen, Dundee, Edinburgh, Glasgow, Glasgow Caledonian, Heriot-Watt, Napier, Paisley, Robert Gordon, St. Andrews, Stirling, and Strathclyde. Aberdeen, Glasgow, and St. Andrews were founded in the 1400's. Edinburgh and Glasgow are the largest universities.

Religion. The Church of Scotland, a Presbyterian church, is the official church. But the people may worship as they choose. Many Scots are Baptists, Episcopalians, Methodists, Roman Catholics, or members of Presbyterian churches other than the Church of Scotland.

The Church of Scotland has about 2 million members. The members elect about 1,250 ministers and *elders* (officers) of the church to the General Assembly of the Church of Scotland, which meets once a year. The assembly is often called the *Voice of Scotland* because it discusses national and world affairs as well as church matters. The British monarch may attend the assembly.

Arts. Scotland has produced many famous artists, especially in the field of literature. The earliest Scottish literature was chiefly oral. It was sung or chanted by poet-

singers called *bards*, who composed poetry and songs in the Gaelic language.

Between the 1300's and 1700's, famous Scottish poets included John Barbour, Gavin Douglas, William Dunbar, and Allan Ramsay. Robert Burns, who wrote during the late 1700's, became the national poet of Scotland. He wrote many works in Scots, the literary Scottish dialect. Many modern Scottish poets, including Hugh MacDiarmid, Tom Scott, and Douglas Young, have also used Scots.

Most Scottish prose is written in English. Famous Scottish authors of the 1700's include James Boswell, who wrote a fascinating biography of the English writer Samuel Johnson, and John Arbuthnot, who wrote many great essays. In the 1800's, Thomas Carlyle produced brilliant histories and biographies, and John Lockhart became known for his works of literary criticism. Scotland's best-known novelists, Sir Walter Scott and Robert Louis Stevenson, also wrote during the 1800's. Scott's most famous work is *Ivanhoe* (1819). Stevenson's novels include *Treasure Island* (1883) and *Kidnapped* (1886). The Scottish writer Sir James Barrie wrote *Peter Pan* (1904) and other popular plays.

Scotland's first important painters were the portrait painters Allan Ramsay (the son of the poet) and Sir Henry Raeburn, who lived in the 1700's and early 1800's. Other famous painters since then include Sir James Guthrie, W. Y. Macgregor, William MacTaggart, Sir William Orchardson, John Pettie, and Sir David Wilkie.

Scottish music has traditionally centred on the bagpipe. The Scots divide bagpipe music into big music and little music. *Big music* includes warlike or sad songs called *pibrochs*. *Little music* includes marches and music for dancing. The Scottish reel, the Highland fling, the sword dance, and other traditional dances are performed to little music. The Edinburgh International Festival of the Arts, held in Edinburgh each August, features musical and dramatic productions.

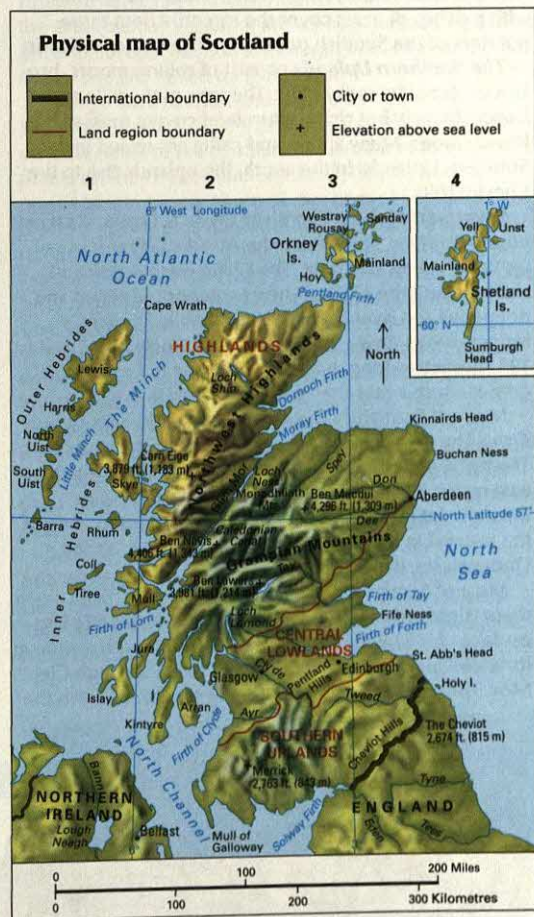
Land

Scotland occupies the northern third of the island of Great Britain. The River Tweed and the Cheviot Hills form Scotland's southern border with England. The North Channel separates southwestern Scotland from Northern Ireland. The northwest coast faces the Atlantic Ocean. The east coast faces the North Sea, which sepa-

rates Scotland from the mainland of Europe. For information on Scotland's climate, see the table with the *Climate* section of **United Kingdom**.

Land regions. Scotland has three main land regions. They are, from north to south, the Highlands, the Central Lowlands, and the Southern Uplands.

The Highlands are a rugged, barren region that covers the northern two-thirds of Scotland. Two major mountain ranges, the Northwest Highlands and the Grampian Mountains, rise in this region. The ranges have parallel ridges that run through the Highlands from



Ben Nevis, centre, the highest peak in the United Kingdom, rises 1,343 metres in the Scottish Highlands.

Physical features

Arran (island)	D 2	Loch Lomond (lake)	D 2
Ben Macdui (peak)	C 3	Loch Ness (lake)	C 2
Ben Nevis (peak)	C 2	Mainland (island)	A 3
Caledonian Canal	C 2	Mainland (island)	A 3
Cape Wrath	A 2	Minch, The (strait)	B 1
Cheviot Hills	E 3	Mondahliath	C 2
Clyde, River	D 2	Mountains	C 2
Dee, River	C 3	Moray Firth (bay)	D 1
Don, River	C 3	Mull (island)	D 1
Firth of Clyde (bay)	E 2	North Channel	E 1
Firth of Forth (bay)	D 3	North Uist (island)	B 1
Firth of Lorn (bay)	D 2	Northwest Highlands	B 2
Firth of Tay (bay)	D 3	Orkney Islands	A 1
Forth, River	D 3	Outer Hebrides	A 3
Glen Mor valley	C 2	Pentland Firth	D 3
Grampian Mountains	C 2	Pentland Hills	D 3
Harris (island)	B 1	Shetland Islands	A 4
Inner Hebrides	C 1	Skye (island)	C 3
Islay (island)	D 2	Solway Firth	C 1
Jura (island)	B 4	South Uist (island)	C 1
Kinnairds Head	D 2	Spy, River	C 3
Kintyre Peninsula	D 2	Tay, River	C 3
Lewis (island)	B 1	Tweed, River	D 3

northeast to southwest. A deep valley called *Glen Mòr* or the *Great Glen* separates the two mountain ranges. The highest peak in the United Kingdom, 1,343-metre Ben Nevis, rises south of Glen Mòr. The Highlands have two kinds of valleys—steep, narrow *glens* and broad, rolling *straths*. Much of the land in the Highlands is a treeless area called a *moor* or *heath*. The most rugged land lies along the west coast. Most Highlanders live on the narrow coastal plains.

The Central Lowlands are crossed by the valleys of the Rivers Clyde, Forth, and Tay. This region has Scotland's best farmland. Wide, fertile fields and low hills with patches of trees cover the region. About three-quarters of the Scottish population live in the lowlands.

The Southern Uplands consist of rolling moors, broken in places by rocky cliffs. The tops of the hills are largely barren, but rich pastureland covers most of the lower slopes. Many sheep and cattle are raised in the Southern Uplands. In the south, the uplands rise to the Cheviot Hills.

Rivers and lakes. The River Clyde is Scotland's most important river. Ships from the Atlantic Ocean can sail up the Clyde to Glasgow. The Clyde was narrow and shallow until the 1700's, when engineers widened and deepened the river to make it navigable. Scotland's longest rivers flow eastward into the North Sea. The Tay, 193 kilometres long, is the largest river in Scotland. It carries more water than any other river in the UK.

Many of Scotland's rivers flow into wide bays called *firths*. The firths of Clyde and Lorn lie on the west coast. The firths of Forth and Tay and Moray Firth are on the east coast. All ships bound for Glasgow must pass through the Firth of Clyde. A suspension bridge, one of the longest in the world, spans the Firth of Forth at Queensferry. It is 2,513 metres long.

Most of Scotland's lakes, which are called *lochs*, lie in deep Highland valleys. Loch Lomond is Scotland's largest lake. It is 37 kilometres long and 8 kilometres wide at its widest point. A series of lakes extends through Glen Mòr. These lakes are connected by canals and form the

Caledonian Canal, which cuts across Scotland from Moray Firth to the Firth of Lorn. One of the canal's lakes, Loch Ness, is famous for its "monster." Some people claim to have seen a creature 9 metres long in the lake. Along the west coast, the Atlantic Ocean extends inland in many narrow bays called *sea lochs*.

Islands. Scotland has hundreds of islands. A large group of islands called the Hebrides lies off the west coast of Scotland's mainland. The Orkney and Shetland groups lie north of the mainland and form the boundary between the North Sea and the Atlantic Ocean.

Economy

During the late 1900's, the economy in Scotland shifted greatly from heavy manufacturing to service industries. In the 1800's and the first half of the 1900's, large numbers of Scots worked in such industries as shipbuilding and engineering. Today, these businesses employ fewer of Scotland's workers. The service industries, light manufacturing, and the energy industry provide most of Scotland's jobs.

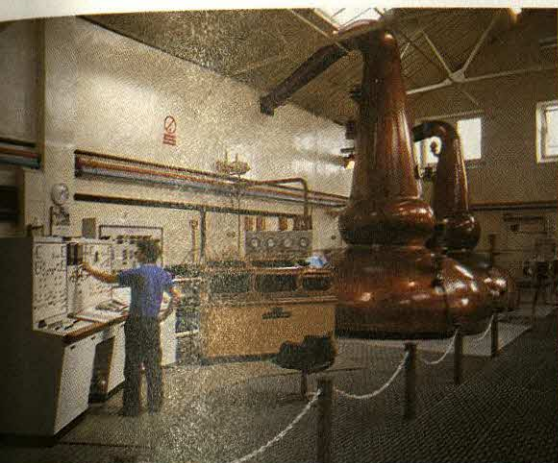
Service industries employ about two-thirds of the labour force in Scotland and account for about two-thirds of Scotland's economic production. Retail sales, finance and business services, education, and medicine lead the service industries in number of employees. Public administration, tourism, transportation, and communications also are major employers. The workforce in Edinburgh has historically been more involved in administration and other service industries than in manufacturing.

Manufacturing. About one-fifth of Scotland's workforce has jobs in manufacturing, which accounts for about one-fifth of Scotland's economic production. The chief manufactured products include food and beverages, electronic equipment, and chemicals. Industrial equipment, woollens, and whisky are products for which Scotland has long been famous.

Agriculture, forestry, and fishing. About three-quarters of the land in Scotland is used for farming.



Glamis Castle, near Dundee, is a major tourist attraction. The castle appears prominently in William Shakespeare's play *Macbeth*. Parts of the castle date from the 1400's.



Malt whisky distilling is an important industry. Modern electronic equipment is used to monitor the distilling process.

Most of the land consists of *rough grazings*, rangelands that farmers use for grazing livestock. Scottish farmers have developed many famous breeds of beef and dairy cattle, including Ayrshire, Aberdeen-Angus, Galloway, and Highland. They also developed the Clydesdale workhorse; the Shetland pony; and a sheepdog, the collie.

Livestock products, such as meat, milk, and wool, account for about three-quarters of Scotland's farm production. In the northeast, farmers produce much beef. Milk ranks as a major product in the southwest, which is traditionally associated with Ayrshire cattle. Farmers raise Scottish Blackface sheep on the rangelands of the Highlands and of southern Scotland.

Less than one-fifth of Scotland's land is suitable for growing crops. Farmers plant mainly grain, including

barley, oats, and wheat. Much of the barley is used for brewing and distilling. Most of the remainder becomes livestock feed. Potatoes are also an important crop. Families own and operate most of the farms in Scotland.

Scotland's forest area almost tripled during the 1900's. However, forests cover only about 15 per cent of Scotland's land area. The government has provided grants, and the state forestry service has planted trees to encourage expansion of Scotland's forests.

Fishing is an important activity in coastal towns. Important catches include haddock, cod, mackerel, herring, lobsters, and prawns. Aberdeen and Peterhead, on the east coast of Scotland, are among the leading fishing ports in Europe. Salmon are caught in the Tay and other rivers, and are raised on fish farms.

Energy sources. Oil and gas fields under the North Sea provide much of Scotland's energy. Pipelines connect the fields to the Scottish mainland and to shipment points on the Orkney and Shetland islands. Nuclear power plants supply about 45 per cent of Scotland's electricity. Coal provides about 20 per cent, and natural gas and hydroelectric power plants supply most of the rest. Since the 1970's, when the production of North Sea oil and gas began, coal mining has greatly declined. Coal was formerly Scotland's main energy source.

Transportation and communication. A dense network of roads serves most of Scotland. Fast highways link the main cities, and most highways are free of tolls. The government owns the railways, which serve the major towns and cities in Scotland. Scotland's major airports are at Glasgow, Edinburgh, Prestwick, and Aberdeen. The world's busiest helicopter port is also at Aberdeen, where it serves the offshore oil industry.

Scotland has 12 daily newspapers. *The Scotsman*, published in Edinburgh, and *The Herald*, published in Glasgow, are Scotland's most influential newspapers.

Scotland receives radio and television programmes from the British Broadcasting Corporation. It also re-



Much of Scotland's land is used for livestock farming. Scottish farmers have developed many famous breeds of farm animals, including Highland cattle, *above*. These cattle are well adapted to survive the cold and winds of bleak pasture.



North Sea petroleum is an important source of Scotland's income. Most of the country's oil and gas fields are concentrated northeast of the Shetland Islands. Production platforms such as this one can withstand rough seas and hazardous winds.



Scotland's islands present remarkable changes of scenery. Tourists travel to the island of Staffa, *left*, to see Fingal's Cave and its tall basalt pillars. Skye, *right*, the largest island of the Inner Hebrides, is mostly moorland. Its mountains attract many climbers.

ceives programmes from companies working under the Independent Television Commission.

Tourism. Scotland's beautiful scenery and vigorous cultural life attract many tourists to the country. The tourist industry now makes an important contribution to the economy. In 1990, economists estimated that tourism accounted for more than 130,000 jobs.

Related articles in *World Book* include:

Regions and island areas

Borders Region	Lothian Region
Central Region	Orkney
Dumfries and Galloway Region	Shetland
Fife Region	Strathclyde Region
Grampian Region	Tayside Region
Hebrides	Western Isles
Highland Region	

Cities

Aberdeen	Gretna Green
Dundee	Inverness
Edinburgh	Saint Andrews
Glasgow	

Physical features

Ben Nevis	Inchcape Rock
Clyde, River	Loch Lomond
Firth of Clyde	Tay
Firth of Forth	Tweed, River

Other related articles

Bagpipe	Europe (picture: The North-west Mountains region)
Barbour, John	Glasgow, University of
Barrie, Sir James Matthew	Golf (History)
Boswell, James	Loch Ness Monster
Burns, Robert	Raeburn, Sir Henry
Carlyle, Thomas	Scott, Sir Walter
Clan	Stevenson, Robert Louis
Curling	Tartan
Dunbar, William	Tweed
Edinburgh, University of	

Outline

I. Government

- A. The Scottish Office
- B. Local government
- C. Devolution

II. People

- A. Population
- B. Ancestry
- C. Language

III. Way of life

- A. City life
- B. Rural life
- C. Food and drink
- D. Recreation

- E. Education
- F. Religion
- G. Arts

IV. Land

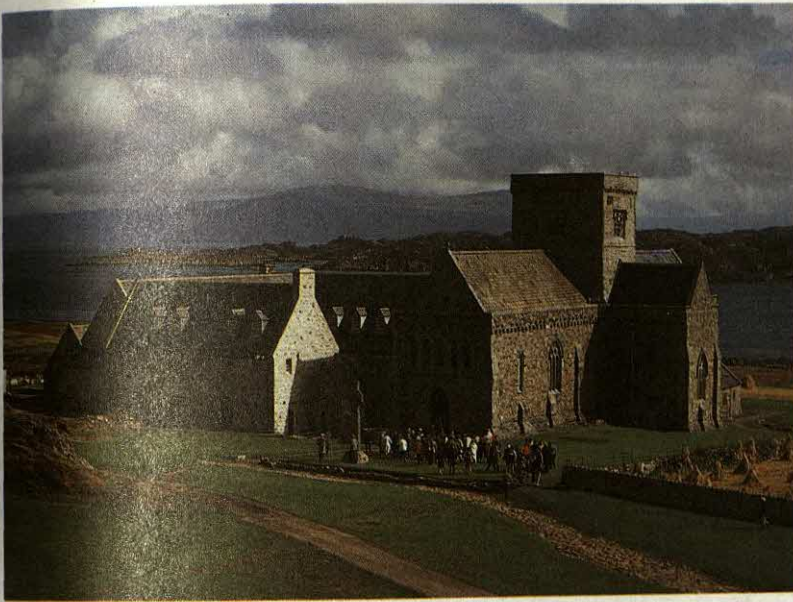
- A. Land regions
- B. Rivers and lakes
- C. Islands

V. Economy

- A. Service industries
- B. Manufacturing
- C. Agriculture, forestry, and fishing
- D. Energy sources
- E. Transportation and communication
- F. Tourism

Questions

- What are *glens*, *straths*, and *moors*? Where are they found in Scotland?
- What are some popular foods in Scotland?
- Who is Scotland's chief administrative official?
- What is *devolution*?
- What are the Highland Games?
- What is a *clan*?
- Where are most of Scotland's oil and gas fields?
- Why is the General Assembly of the Church of Scotland often referred to as the *Voice of Scotland*?
- What are *rough grazings*? How are they important to Scottish farmers?
- What are some famous breeds of animals developed by the Scots?



Scotland became a Christian country in the A.D. 400's. St. Columba arrived on Iona in 563 and founded an abbey. The building has since been restored.

History of Scotland

Scotland, History of. The first settlers in what is now Scotland may have arrived soon after the end of the last Ice Age. But the earliest archaeological remains so far found date from about 6000 B.C. Scotland's earliest inhabitants were migrant hunters and fishermen who came by sea from the south. They were few in number and lived mainly in coastal areas. Their culture belonged to the *mesolithic* (Middle Stone Age) period.

During the *neolithic* (New Stone Age) period, settlers arrived in larger numbers. Until recently, the only known remains of these neolithic people were the chambered stone mounds, called *cairns*, in which they buried their dead. Pottery, bones, and grain found with these burials indicated that neolithic people in Scotland carried on mixed farming and possessed some social order. Then, in the late 1970's, archaeologists found a huge timber hall on Deeside, which they believe dates from the neolithic period.

In the later part of the neolithic period, metalworking had already started to replace stoneworking in Scotland. A new race of people arrived, perhaps from Germany, who were taller and heavier in build than the earlier inhabitants. Among the goods these people buried with their dead were beakerlike vessels, and archaeologists refer to them as the *Beaker Folk* or *Beaker People*.

After 2000 B.C., people began making things of bronze. Collections of weapons that survive from the period after 1000 B.C. indicate that warriors ruled the Bronze Age society of Scotland. After about 700 B.C., people started using iron rather than bronze. Because iron rusts away, few objects from this period have survived. But archaeologists have identified many Iron Age settlements, notably forts.

In the western and northern isles, the inhabitants began in about 1000 B.C. to build hill forts with wooden

ramparts. Later, they built structures called *brochs*. These brochs, shaped like the modern cooling towers of nuclear generating stations, may have been places of refuge from attacks by raiders seeking slaves. Brochs date from the period from 100 B.C. to A.D. 200.

Historians are not sure where the people who built Scotland's forts and brochs came from. The traditional view is that successive waves of Celtic invaders swept into Britain from central Europe, bringing their language and customs with them. But some scholars have suggested that only limited numbers of Celts migrated to Britain. These scholars believe that extensive contact through trade and commerce gradually spread the Celtic language and culture among people already living in Britain.

The Romans and after

The Romans invaded Britain in A.D. 43. They had subdued the British tribes up to Yorkshire by about 78. When they arrived in Scotland, in the late 70's, the Romans found British tribes living south of the rivers Clyde and Forth. These tribespeople spoke a Celtic language related to Welsh and Cornish. The Romans referred to the people north of the Clyde and Forth as *Picts* (painted people). The name arose from their habit of painting their skin. Evidence indicates that the Picts had lived in northern Scotland since about 700 B.C. or earlier. Their language resembled the Celtic spoken by the Britons to the south, but it also preserved elements of an earlier language not related to other European tongues.

Between 79 and 84, the Roman general Agricola led his forces into Scotland past the Forth, into Pictish territory. The Romans won a great victory over the Picts at Mons Graupius. After Agricola was recalled to Rome in 84, the Romans withdrew southwards. In the 100's, they built Hadrian's Wall, which stretched between the Tyne and the Solway Firth. Then they built the Antonine Wall, connecting the Forth and the Clyde. The Romans later



Long before Celtic culture reached Scotland, New Stone Age people built well-ordered villages, such as Skara Brae, on the island of Orkney.

withdrew still further south. They left Romanized British tribes, such as the Votadini, to police Hadrian's Wall, which became their northern frontier.

Picts, Scots, Angles, and Britons. Starting in the mid-300's, people from Ireland began to settle in the Argyll area of Scotland. They spoke a language that later developed into Gaelic. These people, called *Scots*, joined the Picts in more intensive raids on the south. The Romans withdrew from Britain in the 400's, and Anglo-Saxon peoples invaded the country. The Angles entered Scotland. By 600, they had taken over the area around Edinburgh, formerly controlled by the British Votadini. The remaining Britons formed the kingdom of Strathclyde in the west.

Christianity, brought north by people from southern Britain, spread throughout Scotland. St. Ninian is said to have been a missionary bishop there in the 400's. The Scots further north may have brought Christianity from Ireland. St. Columba sailed to Iona from Ireland in 563 and converted the Picts.

The Vikings settled in Shetland and Orkney in the late 700's. In the 800's, they settled in the Western Isles. Their presence destroyed the link between Ireland and the Scots of Argyll.

From the late 600's, the Picts came to rule Scotland from their base in Pictland, in the northeastern part of the country. The Pictish monarchy absorbed many external influences, especially from the Scots of the west. The Picts often dominated the Scots in the 700's and 800's. Then, in 843, a Scottish king, Kenneth MacAlpine, destroyed the Pictish monarchy and began ruling both peoples from Pictland. The Gaelic language spread to the whole of mainland Scotland north of the River Forth. Pictish disappeared. Historians still do not fully under-

stand why Gaelic culture took over so suddenly and thoroughly.

The kingdom of Scotland

In the late 800's and 900's, the Vikings overran the Anglo-Saxon kingdom of Northumbria. Lothian, its remaining northern province, stood weak and isolated. Between 900 and 970, the Scottish kingdom annexed Lothian. Then, in about 1015, Malcolm II, who reigned from 1005 to 1034, took over the British kingdom of Strathclyde and added it, too, to the kingdom of Scotland. But Orkney and Shetland were Norse and the Scottish kings formally abandoned the Western Isles to Norway in 1098.

From the late 1000's onwards, Scotland gradually lost its mainly Celtic character. It took on a mixture of Celtic and *Anglian* (English) characteristics. Malcolm III Canmore, one of Scotland's greatest early kings, founded a *dynasty* (royal line) whose members were particularly open to influences from England. Malcolm succeeded Macbeth in 1057. He married Margaret, the granddaughter of Edmund Ironside. Soon afterwards, with the coming of William the Conqueror, Scotland exchanged Anglo-Saxon influences for Anglo-Norman ones.

Malcolm III's descendant David I ruled from 1124 to 1153. He was the first to offer land to Anglo-Norman barons in return for various services. David's successors continued this practice until the early 1200's. In this way, Scotland became a feudal state.

Under feudalism, Scotland developed a new system of administration, with a chancellor and chamberlain at court and with locally based justices and sheriffs. The economy improved in Scotland, as in other parts of Europe. Increased prosperity financed the feudal adminis-

tration, promoted greater agricultural production, and provided more food for an increasing population. The "Normanizing" kings founded and developed Scotland's first towns, many of whose settlers were English or Flemish.

In contrast to offering Scottish lands to Norman barons, the Scottish kings sought territory in England. David I took advantage of civil wars in England to extend the Scottish border south to the River Tees. David's marriage to Matilda of Huntingdon gave him a claim to the earldom of Northumberland, which he obtained for his son Henry, who ruled from 1138 until 1152. But David's grandson William lost it in 1157. He came to the throne in 1165 as King William the Lion and pressed ceaselessly for Northumberland's restoration. In 1173, he joined a conspiracy against Henry II of England. He marched on England but was defeated and captured at Alnwick. As a result, Scotland became a *vassal* (dependent) kingdom of England until 1189. William's son Alexander II lost a war against England from 1215 to 1217. In 1237, he gave up all rights to Northumberland.

Alexander II, after his unsuccessful conflict with England, came to terms with his more powerful neighbour Henry III, marrying Henry's sister Joan in 1221. From 1217 to 1296, Scotland and England were at peace. During that time, the Scottish kingdom enjoyed a period of economic stability and good government. The Scots, especially the wealthy ones, began to develop a sense of community and even nationality. Scotland, although tied economically to England, at last began to think of itself as an independent state.

During this period, in 1263, the Scots repulsed a Norwegian attack. As a result of the peace terms made between Scotland and Norway, the Western Isles were restored to Scotland in 1266.

The War for Independence

With the death of Alexander III in 1286, the direct male line of the House of Malcolm Canmore ran out.

Alexander's only descendant was a 3-year-old child, his granddaughter Margaret, the Maid of Norway. Six guardians of the realm, appointed by a group of Scots called the *Community*, governed. They arranged a marriage between Margaret and the son of Edward I of England.

Margaret's death in 1290 led to a dynastic crisis. The Scots were so divided over the succession that they turned to Edward for a choice. Edward demanded that each member of the Community acknowledge him as overlord. In 1292, Edward's court chose John de Baliol (also spelled *Balliol*), a descendant of David I, as heir to the vassal throne.

Edward insisted on his feudal rights and overrode Baliol's authority by hearing appeals in England from Baliol's own court. The resentful Scots forced Baliol into open rebellion. The English defeated the Scots at Dunbar in 1296. Baliol resigned, and Edward occupied Scotland, appointing his own administrators there. Edward also removed the Stone of Scone, upon which the Scottish kings had, he thought, been inaugurated. He had the Coronation Chair in Westminster Abbey built to hold the stone.

In 1297, the angry Scots rebelled against Edward's authority. The leader of one revolt, William Wallace, decisively defeated the English at Stirling. Edward, in turn, won a great victory at Falkirk in 1298, but did not reoccupy Scotland until 1304.

Edward II, who became King of England in 1307, had to face a new rebellion. In 1306, Robert Bruce, whose grandfather had been Baliol's rival for the succession in 1290, seized the throne. Bruce began his bid to free the Scottish kingdom from English control. As Robert I, he took advantage of the great resentment the English occupation caused among the Scottish people.

Robert resolved his great struggle on behalf of Scotland on June 24, 1314, at the Battle of Bannockburn. Edward II, trying to save his last Scottish strongholds, lost decisively. With the fall of Berwick in 1318, all Scotland



Robert Bruce inspired his Scottish supporters before the Battle of Bannockburn by beating Sir Henry de Bohun in single combat.



In Dunfermline Abbey is the tomb of Robert Bruce. He crushed the English at Bannockburn (1314) and freed Scotland.

was free. A truce was made in 1323. In 1327, Robert vowed to renew hostilities unless England acknowledged Scotland's independence. The English did so in 1328.

Edward III launched a costly war against Scotland in 1332. His forces retook Berwick and caused great devastation, but they failed to crush resistance. They captured David II of Scotland, who was trying to help France against England, and held him prisoner from 1346 to 1357. In David's absence, Scotland suffered poor government but, after his release, raised huge sums to pay his ransom. David used some of the ransom money for his own needs. He also earned great unpopularity by agreeing that the king of England would succeed him if he had no male heir. David had no children at all, but his nephew succeeded him as Robert II.

Independent Scotland

The first Stuarts. Robert II was 55 when he came to the throne. He was descended from Walter Fitzalan, High Steward of Scotland. Fitzalan's position of steward gave the family its name, Stuart. Robert II's successor, Robert III, came to the throne in 1390 at the age of 53. He was succeeded in 1406 by 11-year-old James I. English forces had kidnapped James earlier the same year and did not release him until 1424. His uncle Robert, Duke of Albany, ruled as regent until 1420. He made no effort to rescue James from captivity. On his return, James executed Albany's son. James victimized other noble families and imposed unpopular taxes, but he restored order. His murder, at Perth in 1437, resulted from a feud rather than from general discontent.



In Selkirk, the so-called Fletcher Monument, erected in the 1800's, marks the Scots' defeat at Flodden (1513).

James's son, James II, was a child of 6 when he succeeded his father in 1437. Nobles contested for power during his minority. But when James came of age, he quickly took control and ruled actively until 1460, when he was killed at Roxburgh. His successor, James III, was 9 years old. James III's minority was peaceful. From 1465 until James began to rule in his own right, the Boyd family ran the country. James III started his rule well. In 1461, Berwick was restored to Scottish rule. Through a marriage arranged by the Boyds to Margaret of Denmark, James acquired Orkney and Shetland for Scotland, and he deprived the Lord of the Isles of the Earldom of Ross. But James quarrelled with his brothers Alexander, Duke of Albany, and John, Earl of Mar, who died mysteriously. Alexander fled to England and returned with an English army, which recaptured Berwick. James soon became unpopular with his nobles, and the Home family rebelled. After a battle near Stirling in 1488, James was murdered.

The early Stuart period, from 1371 to 1488, was, in some ways, dominated by the powerful barons. The first Stuarts, Robert II and Robert III, were elderly men, inclined to buy off the demanding nobles by granting pensions. This practice and other expenses seriously reduced the Crown's revenues. But the monarchy at this period based its continuing strength on the support it received from both the aristocracy and the *lairds* (gentry). An economic recession in the early 1400's, made worse by intermittent wars with England, disrupted trade and caused a drop in baronial incomes. These circumstances affected the minor landowners less seriously than they did the barons. One family, that of the



Mary, Queen of Scots was executed in England in 1587, after years of imprisonment, on the orders of Elizabeth I of England.

Earls of Douglas, became threateningly powerful. In 1452, James II uncovered a conspiracy. The king took part in the murder of the eighth earl, which provoked the Douglas family into revolt. James crushed the rebels and seized their estates.

The major constitutional development of the early Stuart period was the evolution of a Scottish Parliament. Up to the 1300's, the kings consulted their barons on affairs of state. These councils of barons laid the foundation for the holding of parliaments. In the 1300's, David II had summoned representatives from the ancient burghs to grant taxes. Parliament came to have three *estates* (divisions)—nobles, clergy, and *burghesses* (town representatives).

Major developments also occurred in Scotland's literature during the period from 1300 to 1513. The poets John Barbour, Blind Harry, Robert Henryson, and William Dunbar produced works of brilliant quality. See **Scottish literature (1300-1500)**.

The Renaissance kings

James IV ascended the throne in 1488 at the age of 15. He showed himself to be a vigorous, shrewd, and strong king. In 1502, he signed a definitive peace treaty with Henry VII of England and, in 1503, he married Princess Margaret Tudor. His foreign policy was also peaceful, but the clans continued to be a problem.

Scotland was by now a mainly English-speaking kingdom, with Gaelic-speaking people in the mountains and along the western coast who followed their own customs. James IV destroyed the Lordship of the Isles, which had preserved a kind of order in the Highlands. In the 1500's, the Scottish monarchs came to rely upon the Gordon family, who included the Earls of Huntly, to control the Highland clans, and the Campbell family, including the Earls of Argyll, to control the west. These two families, especially the Campbells, used their position to build up their own possessions. They deprived other families of land and property, creating discontent among the clans.

James IV and his successor, James V, who ruled from 1513 to 1542, lived extravagantly. James IV spent large sums on ships and artillery. James V built costly palaces,

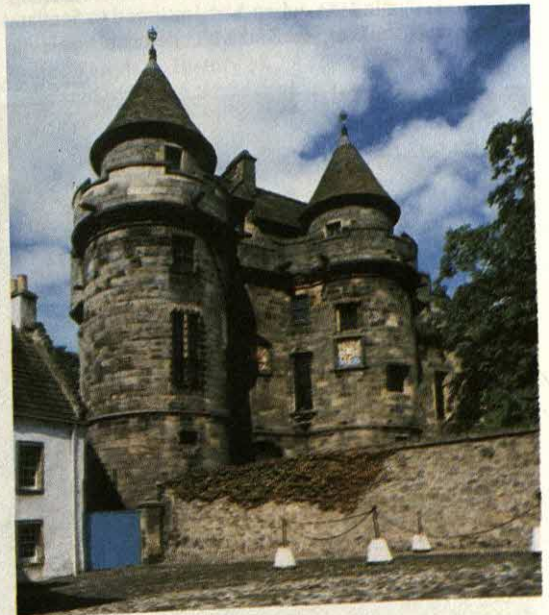
such as Falkland, completed in 1537. In order to raise funds, James IV let crown lands and James V extorted money from the church.

Both James IV and James V made foolish wars on England. James IV had alliances with both France and England. In 1511, these two countries came into conflict, and, faced with an impossible choice, James IV chose to side with France. In the brief war that followed, James IV led a Scottish invasion of England in August 1513. He faced English forces under the Earl of Surrey at Flodden Edge, just south of the River Tweed near Coldstream, on September 9. The Scots suffered a disastrous defeat by the English. James was slain, along with many of the Scots nobility.

James V's war was equally disastrous. He had come to the throne as a child, and French and English interests had jockeyed for position during his minority. A branch of the Douglas family, the Earls of Angus, came to represent the English interest. They held James prisoner during part of his early life, but he drove them out in 1528. He tended to favour France and, in 1538, married Mary of Guise, daughter of a French duke. This marriage angered Henry VIII, who sought to meet with James at York. James's failure to meet with Henry eventually led to war. English troops invaded Scotland but were repulsed. Scottish troops under Oliver Sinclair marched against England and were disastrously defeated at Solway Moss in 1542. James died soon afterwards, leaving his throne to his baby daughter, Mary, Queen of Scots.

The Reformation

As early as the 1100's, under David I, the Scottish church had declared its independence from York. It had supported the Scots in their wars of independence in the 1300's. In the 1400's, it helped found universities at St. Andrew's, Glasgow, and Aberdeen.



Falkland Palace is a masterpiece of Renaissance architecture. It was completed in its present form under James V.

In the 1500's, the development of Protestantism in Europe, especially in England, worried Scotland's Catholic clergy. They paid heavy taxes to James V in the hope that he would not turn Protestant.

The Church faced numerous problems. Some bishops were unsuitable for their work. Poor and ill-educated parish priests, following orders, handed over parish revenues to the monasteries, cathedrals, and universities, leaving too little for themselves. The monasteries, in turn, handed money over to secular rulers, including the monarch. The Church badly needed reform, but too many people profited from its disorganization to permit reform.

From the outset, the Scots were tolerant of a few Lutheran reformers, although some were burned as heretics. John Knox, a disciple of John Calvin, at first found little support for his suggestions of sweeping changes. Then, as the religious issue became a political one, Knox received increased backing. Scottish nobles, anxious to remove the French influence promoted by Mary of Guise, adopted the role of religious reformers. Their actions led to a civil war (1558-1560) that ended in the death of Mary of Guise and the signing of the Treaty of Leith. By the treaty, French troops left Scotland.

The Scottish Parliament outlawed the Mass, denied the authority of the pope, and made Scotland into a Protestant country. Mary, Queen of Scots, daughter of James V and Mary of Guise, had married the French Dauphin, Francis, in 1558, briefly becoming Queen of France in 1559. The crisis of 1559-1560 left her as Scotland's queen. She was 18 years old, an absentee, and a Roman Catholic.

The union of the crowns

Mary, Queen of Scots, was a great-granddaughter of Henry VII of England. In 1558 Mary had offended Queen Elizabeth I by contesting her right to succeed to the English throne. But in 1561, when Mary returned to Scotland from France, she was received with tolerance. She

sought to give Elizabeth no further offence. She kept the Roman Catholic mass in private but followed the advice of her half-brother, the Earl of Moray, and ruled her subjects as Protestants. Later, Mary blundered into marriage with the unstable Henry Stuart, Lord Darnley.

In the course of time, Darnley became jealous of David Rizzio, an Italian musician—possibly a papal agent—who had come to Scotland in 1561 and won his way to the position of Mary's secretary. Darnley joined a conspiracy to murder Rizzio. After the birth of Mary's son James, in 1566, Darnley, too, was murdered. Mary and her new companion, the Earl of Bothwell, were suspects. After Mary married Bothwell, the Scottish nobility rose against them and defeated her forces at Langside. The nobles forced Mary to abdicate, leaving Moray to rule on behalf of the baby king, James VI.

Mary escaped from imprisonment and fled to England. She wanted Elizabeth to help restore her to the Scottish throne. But Elizabeth held her prisoner and eventually, in 1587, had her executed.

James VI was yet another Scottish monarch who came to the throne as an infant. He did not take control of his kingdom until the 1580's. James was able, but lazy, and was easily influenced. He tried to restore the bishops, who had not served since 1560, but was firmly resisted by the new Presbyterian *kirk*. Able ministers saved James's wasted finances and improved the educational system. The economy expanded with new industry. The aristocracy became wealthier. The lairds expanded as a class. But inflation kept Scotland's lower classes poor.

The combined kingdoms. James VI took care not to offend Elizabeth. He even accepted his mother's execution with little protest. When Elizabeth died in 1603, James VI was her closest relative and succeeded her as James I of England. His succession was untroubled. In London, James became isolated from the reality of the situation in Scotland. The church in Scotland accepted his decision to restore the bishops but continued with its Presbyterian assemblies and neglected the king's

Painting by Sir George Harvey; Glasgow Museums and Art Galleries



Covenanters preached to other Scots the message of the National Covenant of 1638. In the Covenant, Scots pledged to fight to support their Presbyterian form of religion.



Charles Edward Stuart's bid to win back the Crown for the Stuarts ended in disaster at the Battle of Culloden in 1746. Prisoners from the battle posed for the painting.

proposals. James did not press the point, but his son Charles I was not so wise. He tried to impose on Scotland the Prayer Book and certain forms of worship. His stand caused the Presbyterians to sign the *National Covenant* in 1638 and led to the Bishop's War of 1639. To buy off the Scots, Charles had to raise money by reviving the English Parliament. His action started a chain of events that led to the Civil War (see **Civil War, English**).

During the Civil War, the English and Scottish parliaments signed the *Solemn League and Covenant* (1643), pledging to wage war together against Charles. But they could not agree on a religious settlement for England. Charles's execution in 1649 turned the Scots against England, and they unsuccessfully gave aid to Charles II in 1650.

Under Oliver Cromwell, who ruled England in the 1650's, Scotland virtually became an English province. The Scots reluctantly accepted bishops again under the Restoration in 1660. The English government controlled the Scottish government through a system of patronage. The majority of Scots, like the English, wished to remain Protestant, and many people welcomed the Glorious Revolution of 1688 as a chance to restore Presbyterianism. Scottish opponents of the settlement that gave William III the throne were easily defeated.

Scotland's prosperity increased after 1660, partly because of trade with the American colonies. The Scots chafed under English control of their Parliament. They even proposed to choose a Protestant heir different from the one chosen by England. Seeing this, the English government engineered the Act of Union in 1707. The English and Scottish kingdoms and parliaments were combined as the United Kingdom and the Parliament of Great Britain. Scotland received 45 seats in the House of Commons and 16 in the Lords.

The Act of Union was not popular in Scotland and was passed only after wholesale bribery. But most Scots accepted it. *Jacobite risings* in 1715 and 1745 to support James Edward Stuart as James VIII and Charles Edward Stuart as Charles III failed to reverse it. The 1745 rebellion received little support, and the Stuart cause collapsed at Culloden in 1746. The clan system was destroyed.

From 1707 onward, the history of Scotland is generally regarded as part of the history of Great Britain. See **United Kingdom, History of**.

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Outline

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VI. The Reformation

VII. The union of the crowns

A. The combined king-
doms

B. The Act of Union

Questions

- What is known about Scotland's earliest inhabitants?
 What peoples lived in Scotland at the time of the Roman invasion?
 Who first brought Christianity to Scotland?
 What country did the Scots originally come from?
 Where did Robert Bruce achieve his greatest victory?
 Who are Scotland's best known early poets?
 What religious movement brought change to Scotland in the 1500s?
 When were the crowns of Scotland and England united?
 How did Scotland's status change in 1707?
 When were the Jacobite risings?

Scotland Yard is the headquarters of the London Metropolitan Police. In popular usage, however, the name *Scotland Yard* means a branch of the London police called the *Criminal Investigation Department* (C.I.D.). The C.I.D. handles all aspects of criminal investigation in metropolitan London, and police departments throughout Great Britain seek its help with difficult cases. Scotland Yard is known throughout the world for its skill and crime-solving techniques.

In addition to the C.I.D., the Metropolitan Police have three other main departments. The Uniform Department patrols the streets to guard against crime and help people with problems. The Traffic Department enforces traffic laws and promotes safety on the roads. The Special Branch functions mainly as an information-gathering agency. It also investigates individuals and groups that may endanger national security and protects government officials and distinguished foreign visitors.

Scott was the family name of two British architects, grandfather and grandson.

Sir George Gilbert Scott (1811-1878), the grandfather, was an architect in neo-Gothic style. In 1840, he won the competition for the Martyrs' Memorial, at Oxford. In 1844, he won the international competition for St. Nicholas's Cathedral in Hamburg, Germany. He also restored many churches and cathedrals, including Ely Cathedral. He was born at Gawcott, near Buckingham.

Sir Giles Gilbert Scott (1880-1960), the grandson, designed ecclesiastical buildings in neo-Gothic style. He restored many others. At the age of 22, Scott won a competition for the design of Liverpool (Anglican) Cathedral. He also designed the new Waterloo Bridge in London and Cambridge University Library. He was born at Gawcott.

Scott, James (1810-1884), a surveyor, explored much of northern Tasmania, Australia. In 1852, the government engaged him to explore the northeast as far as Waterhouse and to report on a possible stock route. On the return journey, he crossed the fertile farming lands around Scottsdale, which was named after him. Scott was born in Scotland and moved to Tasmania in 1832.

Scott, Sir Peter (1909-1989), a British artist and ornithologist, became well known for his paintings of birds and for his broadcasts on conservation and wildlife. As an ornithologist, he founded the Wildfowl Trust in Britain and led expeditions to many parts of the world. A keen yachtsman, he represented Britain in the Olympics and the America's Cup race. In 1963, he won the National Gliding Championship. Scott was chairman of the World Wildlife Fund. His books include *Portrait Drawings* (1949), *Wildfowl of the British Isles* (1957), and *The Eye of the Wind* (1961), his autobiography.

Peter Markham Scott was born in London. His father was Robert Falcon Scott, the explorer.

Scott, Robert Falcon (1868-1912), a British explorer and naval officer, became the first person to reach the South Polar plateau. He reached it on an expedition that took place from 1901 to 1904. On Dec. 30, 1902, Scott reached a latitude of approximately 82° 17', about 840 kilometres from the true South Pole. The latitude reached by Scott was the farthest south that anyone had then gone.

Scott's successes led the British government and Royal Geographical Society to appoint him commander of an expedition to the true South Pole. Leading the expedition, Scott sailed in 1910 from New Zealand on the *Terra Nova*. His party reached Cape Evans on Ross Island and set up headquarters there. Scott started over the ice with sledges in November 1911. The men reached the pole on Jan. 17, 1912, but they found that Roald Amundsen, a Norwegian explorer, had already reached it about five weeks earlier, on Dec. 14, 1911. On the return trip, all five members of the Scott party died. Three bodies, as well as records and diaries the men had kept, were found at their last camping place. Scott was born in Devonport, Devon.

See also **Amundsen, Roald** (The race to the South Pole); **Antarctica** (Exploration; map; picture: A dramatic race to the South Pole).

Scott, Thomas Alison (1777?-1881), grew the first sugar cane in Australia at Port Macquarie in 1824. In 1831, Scott began growing sugar cane on his own land near Gosford. He campaigned vigorously for a local sugar industry. In 1869, the government awarded him an annual pension. He was born in Glasgow, Scotland, and lived eight years in the West Indies.

Scott, Thomas Hobbes (1783?-1860), the first archdeacon of New South Wales, Australia, did much to promote and extend education. He was appointed archdeacon of Australia in 1824 and immediately set about preparing a plan for schools. He assumed that the schools would operate in close connection with the Church of England. Many non-Anglican colonists bitterly opposed this plan. Scott resigned in 1828 and returned to Britain in 1829.

Scott, Sir Walter (1771-1832), was a Scottish romantic writer. He created and popularized historical novels in a long series of works called the *Waverley* novels. In such novels as *Ivanhoe*, *The Heart of Midlothian*, and *The Talisman*, Scott showed his unique genius for recreating social history. He arranged his plots and characters so the reader can enter into the lives of both great and ordinary people who were caught up in violent, dramatic changes in history.

Scott's art shows the influence of the Enlightenment of the 1700s. He believed every human was basically decent, regardless of class, religion, politics, or ancestry. Tolerance for different ways of life is a major theme in his historical works. The *Waverley* novels express his belief in the need for social progress that does not reject the traditions of the past. He was the first novelist to portray peasant characters sympathetically and realistically. He was equally just to people in business, professional soldiers, and even kings.

Scott's amiability, generosity, and modesty made him popular with his fellow writers. He declined the offer of

poet laureate in 1813 and supported Robert Southey, who received the honour. Scott entertained on a grand scale at Abbotsford, his famous estate.

Scott's influence can be seen in the works of Victor Hugo and Honoré de Balzac of France, James Fenimore Cooper of the United States, and Leo Tolstoy of Russia. But despite his influence, Scott's reputation declined from the late 1800's to the mid-1900's. His reputation has begun to rise again. But it probably will never reach the heights it attained during Scott's lifetime, when Goethe exclaimed, "All is great in the *Waverley* Novels: material, effect, characters, execution." Literary historians regard Scott's death in 1832 as marking the close of the romantic age in English literature.

His life. Scott was born in Edinburgh. His father, who was a successful lawyer, had young Walter trained for a law career. Scott became a barrister in 1792, and he practised law actively for many years.

A childhood illness, probably polio, left Scott lame in his right leg. But he had unusual physical strength, and enjoyed taking trips into the Scottish countryside. These trips gave him firsthand knowledge of the life of rural people, and provided material for his first major publication, *Minstrelsy of the Scottish Border* (1802-1803). This book was one of the great early collections of popular songs and ballads. *Minstrelsy* led to his first long verse poem *The Lay of the Last Minstrel* (1805). The poem tells the legend of a famous goblin, and describes much about life along the English-Scottish border in the 1500's.

Scott continued his success at narrative poetry with *Marmion* (1808), which includes his best-known ballad "Lochinvar." In 1810, Scott wrote his most popular story-poem, *The Lady of the Lake*. This romantic tale, set in the Trossach Mountains, deals with picturesque Highland customs and history.

The Waverley novels. After the publication of his first novel, *Waverley*, in 1814, Scott devoted himself primarily to fiction. Scott's progress to historical novels was natural. His talents as a storyteller and as a creator of character, as well as his gift for realistic Scottish dialect, could never find full expression in poetry.

Waverley describes a Scottish rebellion against England in 1745. The novel was published anonymously. However, the book was a success. From 1814 to 1832, Scott published 27 other novels, four plays, and much nonfiction. All of Scott's novels were referred to as part of the *Waverley* series, because the author was identified on the title page only as "The Author of *Waverley*." Scott's authorship was officially revealed in 1827, but it had been known for years.

Scott wrote frequently about the conflicts between different cultures. *Ivanhoe* (1819) deals with the struggle between Normans and Saxons, and *The Talisman* (1825) describes the conflict between Christians and Muslims. The novels dealing with Scottish history are probably Scott's best. They deal with clashes between the new commercial English culture and an older Scottish culture. Scott contrasted the earthy vividness of the Scottish peasants with the formal, stilted language of his English-speaking, upper-class characters. Many critics consider *The Heart of Midlothian* (1818) Scott's best novel. Others prefer *Old Mortality* (1816), which depicts religious strife in Scotland during the late 1600's. Scott's



The Scottish deerhound was bred to hunt wild deer.

other novels in the *Waverley* series include *Rob Roy* (1817), *A Legend of Montrose* (1819), and *Quentin Durward* (1823).

Scottie. See Scottish terrier.

Scottish deerhound was for hundreds of years a dog of the nobility. In Scotland, only people with the rank of earl or higher could own deerhounds. The dog stands from 76 to 81 centimetres, or even taller. It weighs from 34 to 50 kilograms. Its wiry coat is dark blue-grey, light grey, brindle, yellow, sandy red, or fawn red. Scottish lords bred the dog to hunt wild deer.

Scottish law is the law used in Scotland. It is referred to as *scots law* by lawyers. Scottish law uses many principles of Roman law and contains many rules derived from *canon* (Christian Church) law and from feudal and customary law. The Act of Union of 1707, which made Scotland part of the United Kingdom of Great Britain, did not alter the legal system of Scotland or fuse it with that of England. But, under the Act, the British Parliament became the supreme lawmaking body for both countries, and the House of Lords became the final court of appeal from Scottish civil courts.

Scottish civil law differs from English civil law particularly in contract, land law and *conveyancing* (transfer of land), wills and succession, and *family law* (law relating to marriage, adoption, and divorce). For example, English law enforces as contracts only promises made for *consideration*—that is, for something promised or done in return. But Scottish law enforces all promises made for lawful purposes. Scottish land law is basically feudal, and succession to land is governed by rules giving preference to male children and to the eldest child. Jury trials for civil cases are common in Scotland but rare in England. The Scottish law of *delict* or *reparation* is similar to the English law of tort (see **Tort**).

Scottish criminal law is unlike that of most countries that use Roman law principles, because it is not codified. It is unlike English law in its procedure. In Scots law, people suspected of committing crimes are brought to trial only if the public authorities are satisfied that a prosecution is likely to succeed. The authorities conduct their investigations in private. Juries in Scotland

have 12 members. They can reach a verdict by majority decision. They can return verdicts of "guilty," "not guilty," or, if they cannot decide either way, "not proven." If the case is not proven, the accused person goes free.

Scottish literature differs from that of most other countries in that it has been produced in three languages: Gaelic, Scots, and English. Before the 1100's, many people in Scotland spoke Gaelic, but then the number of Gaelic speakers began to decline. Until the 1600's, few Gaelic poets wrote down their work. The Gaelic poetry known to us represents an important literature. In early days, clan chiefs retained poets who celebrated their successes in the hunt or on the battlefield. Many later poets wrote of exile and farewell. See **Gaelic language and Gaelic literature**.

Scots was for many hundreds of years a widely spoken language in Scotland. But the number of Scots speakers began to decline after 1560. In that year, John Knox, the reformer, authorized the issue in Scotland of an English version of the Bible. As a result, English became the language that ordinary people associated with religion. The union of the Scottish and English parliaments in 1707 further weakened the status and authority of the Scots language. But Scots still influences the kind of English that Scottish writers use. Many writers in the 1900's have revived the use of Scots in their work.

1300-1500. The first Scots poets whose work has survived in identifiable form were mainly concerned with celebrating the skill and bravery of their leaders. In two poems, John Barbour (1316?-1395) and Blind Harry (1450?-1492?) celebrated the battles and courage of two great Scottish leaders. The poems are "The Bruce" and "The Acts and Deeds of the Illustrious and Valiant Champion Schir William Wallace." Barbour had great skill in writing narrative verse. But the supreme passage of his poem deals with the delights of freedom. Blind Harry wrote in an exaggerated and rough style. His work is like that of Andrew of Wyntoun (1350?-1420?), whose "Chronicle" is the oldest known long poem in Scots.

Scottish literature of the 1400's was influenced by the English poet Geoffrey Chaucer. When King James I of Scotland spent 18 years as an English prisoner, he read the works of Chaucer. James wrote "The Kingis Quair" ("The King's Book"), a poem in which he described his courtship of an English princess. He used Chaucerian technique in writing his poem. He also introduced closely observed descriptions of nature, which have always remained characteristic of Scottish literature. James's reign became a golden age for poetry in Scotland. The poets of the time came to be known in England as the *Scottish Chaucerians*, but in Scotland they were known as the *Scottish makaris* or *makers* (poets).

The first of the makers, Robert Henryson (1430?-1506), was a schoolmaster from Dunfermline. In his "Moral Fables," based on Aesop's fables, he depicted human weaknesses by telling stories about animals. His pastoral poem "Robert and Makyne" and his continuation of Chaucer's story of Troilus and Criseyde in "The Testament of Cresseid" show that he was the master of a wide emotional range.

William Dunbar (1460-1520?) understood less of human weaknesses than did Henryson, but had a more brilliant technique. He wrote with passion and fierce mental energy. He expressed religious exultation in "Of

the Resurrection of Christ," pointed savagery in "The Flying of Dunbar and Kennedie," and sombre reflection on life in "Lament for the Makaris."

Bishop Gavin Douglas of Dunkeld (1474?-1522) translated Virgil's *Aeneid* into Scots. He added original prologues containing fine pieces of nature description.

1500-1700. Sir David Lyndsay of the Mount (1490-1555) continued the tradition of the earlier poets. He was a satirist who attacked the vices then current in the Church by means of a great morality play called *Ane Pleasant Satire of the Thrie Estatis*.

Much of the good Scots prose of the period is contained in official documents. The earliest important literary prose work was the anonymous *The Complaint of Scotland* (1549). But the *History of the Reformation in Scotland*, written in about 1557 by John Knox (1505?-1572), marked a new development in Scots prose. Knox mingled Scots and English in his passionate account.

Prose writers of the 1600's included diarists, such as Sir James Melville (1535-1617), and pamphleteers, such as Sir Thomas Urquhart (1611-1660). William Drummond of Hawthornden (1585-1649) was the most distinguished of the poets of the 1600's. He chose to write in English rather than in Scots.

1700-1800. Through the 1500's and 1600's, religious troubles had reduced the flow of ballads and popular literature. The religious troubles ended in the 1700's. Allan Ramsay (1686-1758) excelled in depicting in verse what people of his time called "low life." But in addition to such poems as "Elegy on Maggie Johnston," about an innkeeper's wife, he helped make the Scots tongue respectable by publishing an anthology of poems in English and Scots. Robert Fergusson (1750-1774) wrote vivid satirical descriptions of Edinburgh life, such as "Auld Reekie," a nickname for his native city; "Braid Claith," a satire upon outmoded respectability; and "Leith Races," a colourful social study.

Both Fergusson and Ramsay were overshadowed by Robert Burns (1759-1796). Burns expressed in his poetry the national spirit of Scotland. He attacked the tyranny of the Church in such satires as "The Holy Fair," and in "Holy Willie's Prayer," he attacked hypocrisy. He used his great narrative gifts in writing "Tam o' Shanter." He expressed his understanding of men and women in such songs as "Mary Morison." Burns's *Poems, Chiefly in the Scottish Dialect* appeared in 1786. He spent the last years of his life writing original songs to old Scots tunes and improving old songs in the Scots tradition.

Church authorities opposed drama in the 1700's, and few plays were written. Notable prose works included the philosophical writings of David Hume (1711-1776), the influential study *The Wealth of Nations* by Adam Smith (1723-1790), and the *Life of Samuel Johnson* by James Boswell (1740-1795).

1800-1900. Authors of the 1800's are remembered more for their prose than their poetry. James Hogg (1770-1835) wrote a powerful prose study of the effects of belief in the doctrine that those chosen by God cannot help but be saved. This was *The Private Memoirs and Confessions of a Justified Sinner*.

James Macpherson (1736-1796) aroused European interest in Scotland with his poetic-prose epic translations, *Fingal* and *Temora*. He claimed to have translated them from the Gaelic of the old bard Ossian. Modern

scholars are certain that Macpherson forged the Gaelic "originals" that he later produced. However, most believe that he based his work on ancient fragments.

European readers enjoyed the romanticism of Macpherson's work. As a result, they were ready for the romanticism of Sir Walter Scott (1771-1832). Scott's narrative poems "The Lay of the Last Minstrel," "Marmion," and "The Lady of the Lake" were romantic. So were the Waverley novels, which included *Waverley*, *The Anti-quary*, *The Heart of Midlothian*, and *Rob Roy*.

The only novelist of the age who can be compared with Scott was John Galt (1779-1839). In *Annals of the Parish*, he wrote with charm and insight about changing manners. He depicted the Scots character in *Sir Andrew Wylie* and *The Entail*.

Galt was connected with *Blackwood's Magazine*. The editor, John Wilson, who signed himself Christopher North, captured the fun, cleverness, and variety of the Edinburgh literary scene in his series *Noctes Ambrosianae*. *Blackwood's* and the *Edinburgh Review* exerted great influence and had many distinguished contributors. Among them was Scott's son-in-law, John Gibson Lockhart (1794-1854). He wrote a study of Scott.

Thomas Carlyle (1795-1881) influenced many writers with his critical essays and his sternly moral philosophy. He was also a close student of German literature. He wrote *Sartor Resartus* (*The Tailor Retaliored*), a discussion of an imaginary philosophy of clothes, and a *History of the French Revolution*.

Robert Louis Stevenson (1850-1894) wrote both poetry and prose. As a poet, he combined the best elements from several Scots dialects. As a novelist, he often chose historical subjects, as Scott had done. He achieved great popularity with his adventure stories, such as *Treasure Island*, *Kidnapped*, and *Catriona*.

Standards of literature declined in the late 1800's. Writers concentrated on sentimental and parochial subjects. The critic J. H. Millar called them members of the *kailyard* (cabbage patch) school. The most successful kailyarder was Sir James Matthew Barrie (1860-1937). He wrote about the sentimental side of Scottish life. His most enduring success was the play *Peter Pan*.

George Douglas Brown (1869-1902) shattered the cosy, make-believe world of the kailyarders with his novel *The House with the Green Shutters*. He depicted a rural scene in which nearly all the characters were evil.

Neil Munro (1864-1930) continued the tradition of Scott and Stevenson with his romantic tales, such as *Doom Castle* and *Children of Tempest*. John Buchan (1875-1940) wrote stories of adventure and mystery for a wide audience. His novels include *The Thirty-Nine Steps*, *Greenmantle*, and *Huntingtower*.

After 1900. Neil Gunn (1891-1973) wrote about the Highlands in the first novels devoted to a region of Scotland. He wrote *Morning Tide*, *Highland River*, and *The Silver Darlings*. Sir Compton Mackenzie (1883-1972) and Eric Linklater (1899-1974) chose subject matter for novels from wider fields than purely Scottish issues. A. J. Cronin (1896-1981) had great skill in unfolding a narrative.

Dramatists of the 1900's include O. H. Mavor (1888-1951), who wrote under the name James Bridie, and Robert McLellan (1907-1985). Bridie used his plays as a vehicle for his teaching. His plays include *The Sleeping Clergyman* and *Tobias and the Angel*. McLellan deter-

mined to write only in Scots. His best-known plays were *Jamie the Saxt* and *The Flooers o' Edinburgh*.

Scottish poets of the 1900's have been concerned with the Scots language. Hugh MacDiarmid (the pen name of C. M. Grieve, 1892-1978) published a collection of Scots lyrics called *Sangschaw* in 1926. He wrote in a combination of dialects. MacDiarmid questioned accepted Scottish values in "A Drunk Man Looks at the Thistle," which most consider his masterpiece. Later, MacDiarmid was preoccupied with communism. Among his followers was Sydney Goodsir Smith (1915-1975), who developed in a Scots way the extension of poetry's intellectual range achieved by Ezra Pound and T. S. Eliot.

In the mid-1900's, writers grew less concerned with Scots. They wrote in an English that had a Scottish character. The poet Edwin Muir (1887-1959) was much influenced by ballads and myths. Many of his *Collected Poems* have a gravely beautiful character. Two writers, Adam Drinan (the pen name of Joseph MacLeod [1903-1984]), the author of "Men of the Rocks," and George Campbell Hay (1915-1984), the author of "Wind on Loch Fyne," expressed the texture of Gaelic in their English poems. Norman MacCaig (1910-) combined in his poems metaphysical meditation with a lively sense of imagery. Many of his poems evoke the Highland landscape. The Lowland scene was the subject of Maurice Lindsay (1918-). George Mackay Brown (1921-), a poet, novelist, short-story writer, and essayist, describes life in the Orkneys and how that life is affected by the modern world.

Related articles in *World Book* include:

Ballad	Hogg, James
Barbour, John	Hume, David
Barrie, James Matthew	Knox, John
Boswell, James	Lyndsay, Sir David
Bridie, James	MacDiarmid, Hugh
Brown, George Mackay	Mackenzie, Sir Compton
Buchan, John	Muir, Edwin
Burns, Robert	Scott, Sir Walter
Carlyle, Thomas	Smith, Adam
Cronin, A. J.	Smith, Sydney
Dunbar, William	Smollett, Tobias George
Gaelic language	Stevenson, Robert Louis
Gaelic literature	Thomson, James
Gunn, Neil Miller	

Scottish terrier is a breed of dog first reared in the Scottish highlands in the 1800's. Commonly called "Scottie," it is the only breed with the official name of Scottish terrier. But the cairn, Skye, and West Highland white terriers are also native to Scotland. The Scottish terrier is a small dog with short legs and a chunky body. It weighs 8 to 10 kilograms. It has a hard wiry coat and a long head with small upright ears. It may be wheat, sandy, or steel grey in colour, often with darker stripes. It also may be black. See also *Dog* (picture: Terriers).

Scotus. See *Duns Scotus*, John.

Scouring rush. See *Horsetail*.

Scout. The first explorers of the American frontier were usually fur traders. They knew the Indian tribes, found mountain passes, and located camping places. These experienced frontiersmen served as scouts to guide colonial armies. The first settlers to Oregon and California also employed fur traders as guides. The U.S. Army used friendly Indians as scouts. One of the best-known scouts was Kit Carson (see *Carson*, Kit).



Scouting is a worldwide youth movement. There are more than 16 million Scouts, boys and girls, in 150 countries.

Scouting

Scouting is the world's largest voluntary youth movement. It is non-political, and open to both boys and girls. Scouting aims to help young people develop physically, intellectually, socially, and spiritually through challenging recreation. There are more than 16 million Scouts in 150 countries and territories. Since Scouting began, some 250 million people—many of them later famous—have been Scouts.

Scouting has been growing ever since it was founded in 1907. Membership doubled from 1970 to 1990. Much of this growth was in developing countries. During the 1980s Scouting suddenly reappeared in Central and Eastern Europe, in countries where Communist governments had repressed it for many years, often replacing it with youth movements of their own.

Aims of Scouting. Scouting is not just "helping old ladies across the street." It is an education for life. It complements school and family. A Scout makes a personal commitment to a simple code of living—a duty to God or country, a duty to others, and a duty to self. Scouts *learn by doing* in programmes of progressive self-education, working in small groups to develop leadership, group skills, and individual responsibility. Many of these activities bring them in contact with nature. They learn how simplicity, creativity, and discovery come together to provide adventure and challenge.

The range of Scouts' voluntary activity around the world includes health and immunization programmes, building low-cost housing, planting trees, producing food, helping the old and the handicapped, and fighting drug abuse. Scouts are involved in programmes to protect the environment, to increase literacy, in teaching job skills, and in safeguarding the rights of children. Scouts help with relief work to help victims of floods, droughts, earthquakes, and other natural disasters. Lack of clean water and bad sanitation are major

problems in many parts of the world. Scouts are helping to clean up polluted waterways. They help to bring clean water supplies to remote villages. They show other people how to avoid polluting water.

Scouts also work with friends, neighbours, and community leaders in tackling local problems. They work to promote local, national, and international objectives, such as world peace, and international understanding and cooperation.

International Scouting. Scouting is a worldwide movement. Scouts belong to many different cultures, religions, and races. Every four years Scouts from many nations meet in a "World Jamboree," to exchange ideas and experiences.

The members of this worldwide movement are motivated by the movement's basic purpose and principles. These are: adherence to spiritual principles, loyalty to the religion that expresses them, and acceptance of the resulting duties; loyalty to one's country in harmony with the promotion of peace, understanding, and cooperation; responsibility for the development of oneself; participation in the development of society with recognition and respect for the dignity of others, and for the integrity of the natural world.

The original Promise and Law were laid down by Robert Baden-Powell, the founder of the Scout movement. Each country adapts the original Promise and Law to suit its own conditions. The Scout promise is:

- On my honour I promise that I will do my best:
1. To do my duty to God and the King (or God and my Country);
 2. To help other people at all times.
 3. To obey the Scout Law.
- The original Law is:
1. A Scout's honour is to be trusted.
 2. A Scout is loyal.
 3. A Scout's duty is to be useful, and to help others.
 4. A Scout is a friend to all, and a brother to every other Scout.



Conservation is an important Scout activity. These Japanese Scouts are testing water samples.

5. A Scout is courteous.
6. A Scout is a friend to animals.
7. A Scout obeys orders from his parents, Patrol Leader, or Scoutmaster without question.
8. A Scout smiles and whistles under all difficulties.
9. A Scout is thrifty.
10. A Scout is clean in thought, word, and deed.

Organization

Scouts generally wear uniforms, which differ from country to country. The age groups and programmes also vary from one country to another. They are adaptable to the needs of young people, wherever they live.

Generally speaking, Scouting activity starts around the age of 5-7 with programmes for Cub Scouts, or their equivalents. Members continue through variously-named groups of Scouts, Venturers, and Rovers up to the age of 25 or more. Each country has a different programme of activities and different qualifications. Scouts choose activities from the programme, and progress at their own pace. They are awarded badges for proficiency in the tasks and skills they undertake.

The World Organization of the Scout Movement. Scouting worldwide is coordinated by the World Organization of the Scout Movement (WOSM). This is an international, nongovernment organization composed of national Scout organizations. Members of the World Scout Organization are national Scout organizations, not individuals or Scout *troops* (groups). There are 131 national Scout organizations within the WOSM, representing more than 16 million Scouts and leaders. In some countries there is more than one Scout association. Associations in these countries form themselves into a national federation, in order to be a member of the World Organization, since there can be only one member per country. The World Organization works closely with the World Association of Girl Guides and Girl Scouts

(WAGGGS), which has its headquarters in London.

The WOSM has three principal parts: the Conference, the Committee, and the Bureau:

The World Scout Conference is held every three years. It is the "general assembly" of Scouting, made up of all member Scout organizations. Each member organization must adhere to the purpose and principles of World Scouting, and operate as an independent, non-political, and voluntary organization.

Each member organization is represented in the Conference by a maximum of six delegates. Observers authorized by their national Scout organization may also attend. Delegations usually include the top leaders of each national organization, including International Commissioners, and the Scouters responsible for relations with the World Organization of the Scout Movement, and with Scout organizations in other countries.

The aim of the Conference is to promote the unity, integrity, and development of the Scout movement worldwide. It encourages the exchange of ideas and information between members, and makes general policy. It considers reports and recommendations from the World Committee and from member organizations; and conducts the formal business of the World Organization, including elections, applications for membership, amendments to the Constitution, and rules.

The World Scout Committee. The World Scout Conference elects and delegates some of its authority to the World Scout Committee, which meets at least once a year. It is the executive of the organization, responsible for implementing the resolutions of the World Conference, and for acting on its behalf between meetings. The Committee has 14 members, of whom 12 are elected by the Conference. The two remaining members, appointed by the 12 members, are the secretary general of WOSM and the treasurer. Each must come from a different country and represent not that country, but the interests of the movement as a whole. It also appoints subcommittees to deal with specific subjects such as the youth programme, adult leadership, and research.

The World Scout Bureau is the secretariat of the World Organization. It carries out the instructions of the Conference and the Committee. The Bureau is directed by a secretary general, appointed by the World Committee, who acts as the chief administrative officer of the organization.

The Bureau was first established in London in 1920. It moved to Ottawa, Canada, in 1959, and finally to Geneva, Switzerland, in 1968. It has a staff of 31 people who work out of six offices. The head office is in Geneva and there are regional offices in Costa Rica, Egypt, Kenya, the Philippines, and Switzerland.

The secretariat has a number of functions. These include assisting the World and Regional Conferences, and the World and Regional Committees, and their subsidiary bodies. It provides services for the development and promotion of Scouting throughout the world. It maintains relations with member organizations, and assists them in developing Scouting in their country. It encourages the development of Scouting in countries where Scouting may exist, but where there is no member organization. It also supervises the organization of international and regional Scout events, such as world



Scouts in Kenya began a tree planting project in 1979, and have planted over 2 million trees in tree nurseries.



Outdoor pursuits and contact with nature provide adventure and challenge, and encourage teamwork.

and regional jamborees. It maintains relations with international organizations whose activities are concerned with youth matters.

The World Scout Bureau provides the secretariat for WOSM's committees, task forces, and working groups. It assists in the development of youth programmes and publishes regular newsletters, which provide communication among national Scout organizations.

The World Scout Foundation is a separate legal entity, and an integral part of World Scouting. It helps the WOSM by providing part of the finance needed for its activities and for further development. The foundation generates money donations in the form of investment to produce revenue for the benefit of the World Organization.

The Foundation seeks support from governments, foundations, the business community, individuals, and the Scout movement worldwide. It focuses on 30 priority countries with outstanding economic potential. The Foundation's Board is led by an honorary president. In 1990 the honorary president was King Carl XVI Gustaf of Sweden. The Board is responsible for the Foundation's policies and programmes. It has 25 members, who include business people and Scout leaders from more than 12 countries. The Foundation has a permanent Secretariat, headed by a director general, located at the World Scout Bureau in Geneva.

Scouting around the world

Scout membership worldwide ranges from less than 100 in small countries like Monaco to 4.5 million in the United States. Each country has its own emblem, and programmes.

This article describes Scouting in a selected group of countries.

Australia. The Scout Association of Australia was founded in 1908. Its programme emphasizes adventure activities, camping, bushcraft, and fun in Scouting. In 1990, there were 151,000 members. Members can choose from a wide range of activities, with stress placed on those which contribute directly to the community. In the event of disasters, Scouts directly assist the civil authorities.

Water sports form a major part of the programme for all Australian Scouts. The Association owns powered

aircraft and gliders for air activities, and there are many Sea and some Air Scout units.

Because of Australia's immense size, the eight geographical branches have considerable self-management and initiative. The Association is introducing Scouting and Guiding to ethnic minorities such as the Aborigines.

The Association produces over 100 publications to inform Scouts about local and international activities. A programme of Friendship Tours provides for small parties of Scouts and Scouters to visit other countries.

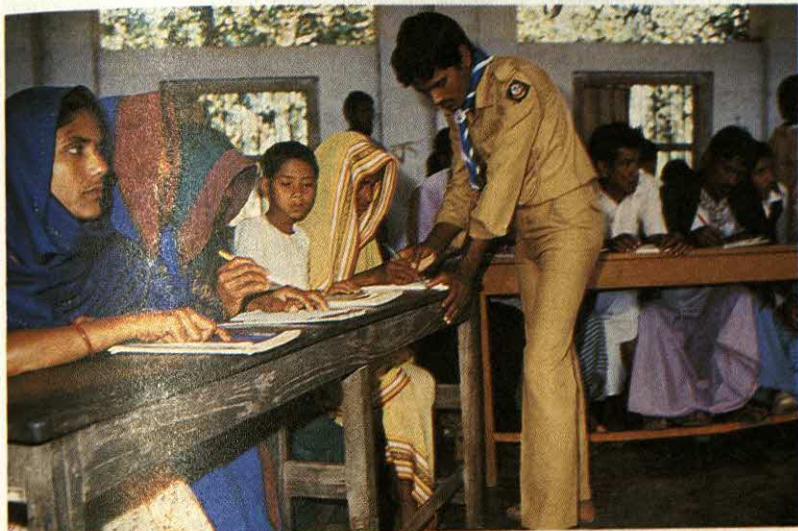
Australia hosted the 16th World Scout Jamboree, and the 31st World Scout Conference in 1988. Some 15,000 Scouts from 94 countries attended the Jamboree, held at Cataract Scout Park near Sydney. The Conference, held in Melbourne, dealt with the theme of Scouting as an education for life.

India. Scouting started in India in 1909. By 1990, there were more than 1.3 million Indian Scouts. Scouting is the most important youth movement in the country. Its activities have never been limited to any particular area, interest, clan, or sect.

Scout and Girl Guide units are separate, although some coeducational activities are held, such as jamborees, rallies, and conferences. Handicapped people also benefit from the Bharat Scouts and Guides programmes. The Association is involved in numerous community service, and community development activities. These include leprosy awareness, sanitation promotion, adult literacy, adopting villages, and the preservation of the environment. Scouts help to provide relief in India during catastrophes such as floods and droughts.

The Indian Scouts organization has a national training centre, and many campsites throughout India. It has four regional offices, and 40 state headquarters.

Ireland. Scouting was founded in Ireland in 1908, a year after the first camp at Brownsea Island in England. In 1990, there were 54,000 members. There are two member associations of the Federation of Irish Scout Associations: the Catholic Boy Scouts of Ireland (CBSI) and the Scout Association of Ireland (SAI). The two member associations cooperate at all levels, and share joint activities and training schemes. The Federation has engaged in a Human Settlements Programme in East Africa, where Scouts helped to build homes, dispensaries, and classrooms.



Education is a major concern of Scouting. Here a Bangladeshi Scout teaches a literacy class.

The Catholic Boy Scouts of Ireland's programme is based on progressive training for members from the age of 6 to 19. Emphasis is placed on award schemes; indoor and outdoor activities; cultural, sporting, and community ideals; and joint activities with other Scouting and Guiding groups. Although the association is primarily based on Catholic principles, non-Catholics and non-Christians are welcome to join the Association.

The Scout Association of Ireland is coeducational, multid denominational, and community-based. It serves over 17,000 young people. It is introducing major changes to reflect a response to the changing needs of young Irish people. Young people are becoming more and more involved at all levels of decision-making, from local to national levels. Greater emphasis is being placed on programme development and support, particularly at local level, and new short-term programme options have been introduced. These recognize the need to attract new-style volunteers with short-term time commitments and availability. The Association also helps to bring handicapped young people into Scouting.

The Scout Association of Ireland works closely with the Catholic Boy Scouts of Ireland, and with the Guide organizations.

The Scout Association of Ireland has always been involved in wider youth work. It participates fully in the National Youth Council of Ireland, the coordinating body for youth organizations in Ireland. It has developed regional outdoor programmes for the senior sections. These provide adventure and training in teamwork, leadership, stamina, and resourcefulness.

There are several activity and training centres around the country, including a lightship. The centres and the outdoor programmes welcome participation by Scouts from other countries.

Malaysia. The Scouts Association of Malaysia was founded in 1911. In 1990, there were nearly 88,000 members. Scouting in Malaysia concentrates on progressive vocational training, public service, and food production. In rural areas, Scouts learn improved techniques of rice

planting, harvesting, poultry rearing, and gardening. They join with other organizations to combat diseases, such as dengue fever. Community service activities include helping the authorities with disaster relief.

The government organizes campaigns for the conservation of nature, in which Scouts actively participate. They also work closely with the community development section of the Ministry of Agriculture.

The Malaysia Association welcomes handicapped members, and has a number of programmes adapted to their needs. All meetings are held outdoors, and nearly all Scout groups are attached to schools.

Philippines. Scouting reached the Philippines in 1923, and by 1990 membership had reached more than 2.2 million. One out of every four boys is a Scout. Scouts are active in community development and service activities.

The Philippines consist of a great many islands, so much of the organization and training is carried out at local levels. There are a number of permanent training camps, several of which are self-supporting.

The organization uses the Red Cross services and training programmes for first aid and water safety. There is an anti-drug abuse programme, and other community service activities. Major activities include conservation, reforestation, and food production. These are carried out in cooperation with various agencies. Scout properties and home gardens are used to plant fruit trees and crops. Scouts have planted several million trees, and cultivate tree seedlings in their nurseries.

Singapore. Scouting reached Singapore in 1910. By 1990, membership had grown to more than 13,000. Singapore's multicultural population lives in densely populated urban areas. Working together is therefore a necessity for everyone. Scouts frequently work with other organizations.

There is an antidrug abuse badge scheme, and courses are conducted for Scout leaders by the Singapore Anti-Narcotics Association. Other community-oriented programmes include crime prevention, road safety, and community living. The police department



Camping trips give Scouts opportunities to develop physical and social skills. These Canadian Boy Scouts are learning to make a fire in the open.

helps the Association with crime prevention and road safety courses.

South Africa. Scouting was founded in South Africa in 1908, a year after its birth in the United Kingdom (UK). In 1990, there were some 58,000 South African Scouts. Membership of the Boy Scouts of South Africa is open to boys and adults of all ethnic groups who voluntarily accept the aims and method of the movement. Particular emphasis is given to special activities for older Scouts, including adventure activities, hikes, and safaris into remote areas.

There has been a strong growth in membership, as a direct result of a policy that Scouting should be available to, and affordable by, all boys. Scouting has contributed in "building bridges" between racial groups and creating better relations in the country's complex society.

United Kingdom. Membership in 1990 was almost 700,000. The United Kingdom was the birthplace of Scouting, which is the largest uniformed youth organization for boys in the UK. Joint activities with the Girl Guides are encouraged. The Venture Scout section has been opened to girls for many years. In 1990, the UK Scouts Association announced that all units would be open to girls, as well as boys.

A progressive programme through the age groups provides for a wide range of interests and skills. The Association provides adapted training programmes for physically handicapped Scouts and for slow learners. Where possible these girls and boys are integrated into regular Scout groups, while others belong to groups connected with special schools.

Sea Scout and Air Scout groups enable young people to develop specialized interests, in addition to basic Scouting. Scoutreach, a programme to develop Scouting in inner-city areas, in rural communities, and in other deprived localities, helps young people to receive Scout training in areas where no opportunities existed before. The Scout Association is also working to strengthen its position in minority ethnic communities.

International activities include exchange visits; an Explorer Belt Scheme, which involves the planning and completion of a 180-kilometre expedition abroad; partic-

ipation in the annual "Jamboree-on-the-Air" organization by licensed Scout radio amateurs; regular International Camps; and other special projects.

United States. Scouting in the United States began with the foundation of the organization Boy Scouts of America in 1910. The organizers established the organization along the same lines as those developed in the United Kingdom. Boys from 7 to 20 years old may take part in Scouting activities. The Scouting programme has three levels in order of age: Cub Scouting (7-10), Boy Scouting (11-18), and Exploring (14-20). Young women may join the Explorers section at age 14.

International activities

Boys and girls in the Scouting movement work primarily in their own communities, but the idea of Scouting as an international organization is ever-present. It is encouraged by major events which bring together thousands of young people from different countries.

Jamborees, or international gatherings, are among the most important events in Scouting. During a national jamboree, Scouts from all over a country spend from a week to 10 days in camp together. Scouts from other countries are frequently invited.

During the World Jamborees, held every four years, Scouts from all parts of the world meet. Some jamborees have attracted up to 50,000 Scouts. Jamborees include demonstrations of Scouting skills and activities, as well as pageants and challenges. There are displays to show the clothing, customs, hobbies, crafts, and history of the nations represented.

The first World Jamboree was in the United Kingdom in 1920, when 301 Scouts from 32 countries camped together. There have been other World Jamborees in England, and also in Australia, Austria, Canada, Denmark, France, Greece, Hungary, Japan, the Netherlands, Norway, the Philippines, South Korea, and the United States.

Another annual international event is the *Jamboree-on-the-Air* (JOTA). Thousands of Scouts who are interested in amateur radio make contact by radio with Scouts and Girl Guides all over the world during the third weekend of October.

World Moots are frequent gatherings of senior branches of national Scout organizations (traditionally called Rovers), and other young adult members ranging from 18 to 25 years of age. They meet to improve their international understanding.

Twining between Scout troops, districts, and national associations in various countries is another way in which Scouts learn to recognize and respect differences between peoples.

The Kandersteg International Scouts Centre in Switzerland offers an opportunity for Scouts and Guides to meet. They can enjoy camping, skiing, mountaineering, and rock climbing, with young people from other countries and cultures.

History

The first Scout camp was held in 1907 in England. It took place during the first nine days of August at Brownsea Island, near Poole, in Dorset. Just 20 boys took part in an experimental camp, based on the ideas of Robert Baden-Powell. In 1908, Baden-Powell, already a national hero in Britain for his part in helping to defend Maf-

king (now Mafikeng) in South Africa during the Anglo-Boer War, published his book *Scouting for Boys*. The book was so popular that it led to a movement that adopted the name of The Boy Scouts.

By 1909, the Scout Movement had taken firm root, and Baden-Powell's book had been translated into five languages. By 1910, Scouting had spread to Canada and the United States.

During World War I (1914-1918), Scouts in Britain and elsewhere contributed to the Allied war effort. Sea Scouts took the place of regular coastguardmen, allowing them to serve at sea.

The first World Jamboree was held in 1920. It proved that young people of many nationalities could come together to share common interests and ideals. Since that time, further World Jamborees have been held at four-year intervals.

Between the two world wars, Scouting flourished in all parts of the world, except in fascist and Communist countries where it was banned. During World War II (1939-1945), Scouts undertook many national service tasks. These included messenger service, fire watching, stretcher bearing, and scrap collection.

Related articles in *World Book* include:

Baden-Powell, Lord

Girl Guides and Girl Scouts

Outline

I. Introduction

A. Aims of Scouting

B. International Scouting

II. Organization

A. The World Organization of the Scout Movement

B. The World Scout Conference

C. The World Scout Committee

D. The World Scout Bureau

E. The World Scout Foundation

III. Scouting around the world

A. Australia

F. Singapore

B. India

G. South Africa

C. Ireland

H. United Kingdom

D. Malaysia

I. United States

E. Philippines

IV. International activities

V. History

Questions

How many Scouts are there in the world today?

When was Scouting founded?

How do Scouts help their communities?

What does a Scout promise to do?

How many national Scout organizations are there?

Where is the head office of the World Scout Bureau?

What is a national jamboree?

How often are world jamborees held?

Who founded the Scout movement?

How did the founder first become famous?

Scraple. See *Prion*.

Screen, Projection. See *Projection screen*.

Screen process printing. See *Printing* (Other printing processes).

Screw is an inclined plane wrapped in a spiral around a shaft. The screw is one of the *six simple machines* developed in ancient times. The other five are the lever, the wheel and axle, the pulley, the inclined plane, and the wedge. See *Machine* (Six simple machines).

A screw consists of two main parts—the *body* and the *thread*. The body of a screw may be a cone or a cylinder. The centre line of the body is called the *axis*. The thread is the inclined plane that sticks out from the body. The

distance between two *adjacent* (neighbouring) crests of the thread is known as the *pitch*.

Uses. Screws have many practical applications, especially as fasteners. The most common are the *wood screw* and *machine screw*. When rotated, such screws can be made to move into, or out of, an object. As the screw rotates one full turn, it travels a distance equal to its pitch. Most wood screws and machine screws have a slotted or recessed head into which a screwdriver is placed in order to turn the screw. Screws come in various sizes and shapes. They are made of steel, copper, aluminium, and other metals that are easy to form.

Screws perform many other functions. Screws open and close nearly all vices. The screw's ability to overcome resistance with relatively little force makes it ideal for use in boring and drilling tools. A *screw jack* combines a screw with a lever. This device raises heavy loads without requiring great effort. Screw jacks can lift automobiles and other heavy objects, even houses.

Many screws help produce motion. A *marine screw propeller* pushes water backward, causing the boat or ship to move forward. Similarly, an aeroplane propeller is an *airscrew* that pushes back air and makes the plane move forward.

The screw also performs important operations in delicate and complex machinery. *Differential screws* enable

Some kinds of screws



Round head machine screw



Flat head machine screw



Pan head tapping screw



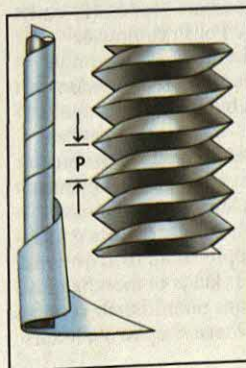
Round head wood screw



Flat head wood screw



Hexagonal head tapping screw



A screw is an inclined plane that spirals around a pole. A strip of paper wrapped around a tube, far left, illustrates this principle. The spiral part that extends from the pole is called the *thread*. The distance between threads, indicated by the letter P, left, is known as the *pitch*.

objects to be spaced apart with great precision. The rotation of special screws in timing devices causes switches to turn on or off at certain times. The *micrometer* uses the revolutions of extremely fine threads to measure small dimensions with great accuracy (see *Micrometer*).

History. Some historians claim a Greek philosopher and mathematician named Archytas, who lived about 400 B.C., invented the screw. The ancient Greeks used screws for various purposes. The Greek inventor Archimedes supposedly developed a machine that uses a screw to raise water. The *Archimedean screw* consists of a large screw inside a tube. The lower end of the device is placed in the water and the screw is rotated within the tube to transfer the water gradually to the upper end (see *Archimedean screw*). The ancient Greeks also developed the *screw press*, a device consisting of two flat surfaces connected with screws. Tightening the screws brings the surfaces closer and closer together and puts increasing pressure on whatever is placed between the surfaces. The Greeks used the screw press to squeeze juice from grapes to make wine and from olives to produce oil.

For many centuries, screws were made with simple hand tools. But during the 1500's, engineers developed the *screw-cutting lathe*, a machine that permitted more efficient and precise production of wooden and metal screws. Screws then began to replace nails and pegs as fasteners in joining hinges and other metal items to wood and in holding together parts of locks, watches, and other articles. Advancements in techniques for cutting finer, more exact threads led to the adoption in the mid-1800's of the first standardized screw thread. Screws with points that could be easily twisted through wood also appeared during the 1800's. Previously, all screws had flat ends and could be inserted only in specially drilled holes.

See also **Bolt**.

Screw, Archimedean. See *Archimedean screw*; *Archimedes*.

Scriabin, Alexander (1872-1915), was a Russian composer and pianist. In 1908, he came under the influence of mystical and philosophical ideas that dominated his best-known music. He even created a special "mystic" chord that became the harmonic and thematic basis of his later works.

Scriabin's major orchestral compositions are *The Poem of Ecstasy* (1908) and *Prometheus* (1911). However, Scriabin wrote most of his works for solo piano, including 10 sonatas and many preludes and études. His early works show the influence of the Polish composer Frédéric Chopin, but later works moved increasingly away from defined tonality toward modern harmonies.

Alexander Nikolayevich Scriabin (sometimes spelled Skryabin) was born in Moscow. After teaching at the Moscow Conservatory from 1898 to 1903, he devoted himself to a career as a composer and concert pianist. **Scribe** is a person who writes letters, documents, or books by hand. Scribes were especially important in ancient societies in which few people could read or write. Many ancient scribes worked for kings or merchants or as religious officials. Some scribes offered their services to the public in market places. There, they wrote letters or documents for a fee.

Scribes who worked for a king kept tax records, wrote out the king's instructions to government officials, and recorded laws. For merchants, scribes recorded business transactions. For the general public they drew up contracts and property deeds. As religious officials, scribes transcribed sacred literature, among their other duties.

In Biblical times, Jewish scribes became teachers and interpreters of laws. The priest Ezra was a scribe. The New Testament includes many negative references to scribes as hypocrites. In the Middle Ages, monks worked as scribes to copy books. Many monks concentrated on *illuminating* (decorating) their manuscripts with intricate designs. For more information about medieval scribes, see **Book** (The Middle Ages).

Today, scribes still write the scrolls used in Jewish worship. In preparation for this task, scribes must purify themselves by taking a ritual bath.

See also **Communication** (During the Middle Ages; picture: During the Middle Ages); **Education** (Sumerian and Egyptian education; Other Middle Eastern education); **Egypt, Ancient** (Education); **Handwriting** (History); **Manuscript**; **Bible** (picture: Saint Jerome); **World, History of** (the picture: Medieval monks).

Scribe, Augustin Eugène (1791-1861), was a French playwright. He was the first successful author of a form of realistic drama called the *well-made play*. Such plays rely for their impact on the careful explanation of past events while, at the same time, indicating events to come. A well-made play contains an *obligatory scene* at the climax in which a secret is disclosed. As a result of the revelation, the characters receive the rewards or punishment they deserve.

Scribe set many of his plays, including *A Glass of Water* (1842) and *Adrienne Lecouvreur* (1849), against interesting political backgrounds. But all of Scribe's plays are basically slight, romantic works and are no longer fashionable. However, the well-made play he pioneered greatly influenced such modern playwrights as Henrik Ibsen, Arthur Miller, and George Bernard Shaw.

Augustin Scribe was born in Paris. In addition to writing more than 300 plays, he also wrote a large number of stories for operas.

Scribner was the family name of two American book publishers, father and son. Charles Scribner, Sr. (1854-1930), and Charles Scribner, Jr. (1890-1952), were the second and third members to head the Scribner publishing firm since its founding in New York City in 1846. Charles Scribner, Sr., reorganized his father's company into Charles Scribner's Sons in 1878. Under his direction and that of his son, the firm published works which helped to make many authors famous. Both Scribners were born in New York City.

Script. See **Television** (Writers); **Theatre** (Interpreting the script).

Scriptures. See **Religion** (Chief characteristics of religion).

Scrofula is a type of tuberculosis that attacks the *lymph nodes* of the neck. These tissues help the body fight disease by filtering bacteria and other microbes from the throat. Most cases of scrofula are caused by drinking unpasteurized milk from cows that have tuberculosis. Such milk contains tuberculosis bacteria. Pasteurization kills the tuberculosis bacteria, and almost no

cases of scrofula occur in nations where milk is regularly pasteurized.

Scrofula occurs most frequently in young children. The tuberculosis bacteria infect the lymph nodes in the neck, making them swollen and lumpy. The infected nodes may gradually swell for months or even years. During this time, most scrofula patients have no pain or fever, and many feel generally well. Eventually, swellings may break open, releasing pus and creating sores on the neck. After the sores heal, the surrounding skin remains red and crusty.

Doctors distinguish scrofula from other causes of swollen lymph nodes by examining samples of the infected tissue under a microscope. They also diagnose scrofula by growing bacteria from the infection in a laboratory. Most cases of scrofula can be cured with antituberculosis drugs.

See also **Lymphatic system** (Lymph nodes); **Tuberculosis**.

Scroll is a roll of paper, parchment, or other material, especially with writing on it. Most scrolls are wound around rods of bronze, ivory, or wood. Sometimes the rods are decorated at both ends with small knobs or other ornaments. The knobs protect the scrolls and make them easier to handle. A scroll is often fastened at both ends so it can be unwound from one rod and rolled up onto the other as it is used.

The Egyptians began using scrolls of papyrus during the 2000's B.C. Beginning in the 1000's B.C., the Hebrews favoured leather scrolls for their sacred writings because leather outlasted papyrus. Later, the Greeks and Romans popularized the use of parchment, a more durable writing material. They pasted together many sheets side by side to form long strips that were wound around the rods. The Chinese and Japanese still use silk and paper scrolls for paintings and writings.



A scroll serves as the manuscript of the *Torah*, the first five books of the Hebrew Bible. It is made of strips of leather.

A spiral design, which resembles the end of a loosely wound scroll, appears in Greek and Roman architecture. Ionic columns are decorated with carved, spiral scrolls called *volutes*.

Related articles in World Book include:

Bible (picture)	Dead Sea Scrolls
Book (picture)	Manuscript
Chinese literature (picture)	Papyrus

Scrooge. See **Dickens, Charles** (The first phase).

Scruple is a unit of apothecaries' weight, a system of weights once widely used in drug measurement. The scruple is equal to 20 grains, or 1.296 grams.

Scuba diving. See **Skin diving** (Scuba diving); **Diving**, **Underwater** (Ambient diving).

Scullard, Howard Hayes (1903-1983), was an English expert on the history of ancient Rome. Scullard's published works concentrate mainly on the Roman Republic, but one of his best-known books, *From the Gracchi to Nero* (1959), is a factual account and astute analysis of the transition from Republic to Empire. Scullard's other works include *A History of the Roman World from 753 to 146 B.C.* (1935), *A History of the Roman World from 146 to 30 B.C.* (1953), *Rome and the Etruscan Cities* (1967), *The Elephant in the Greek and Roman World* (1974), and *Roman Britain: Outpost of Empire* (1979). He was a joint editor of *The Oxford Classical Dictionary*.

Scullard was born in London and educated at Highgate School and St. John's College, Cambridge. He was reader in ancient history at King's College, London, from 1935 to 1959, and professor from 1959 to 1970.

Scullin, James (1876-1953), a leader of the Labor Party in Australia, was prime minister of Australia from 1929 to 1931. His government encountered many difficulties during a period of economic depression. It failed to deal adequately with the crises, and a split developed between it and the Labor Party outside the federal Parliament. James Henry Scullin was born in Trawalla, Victoria. He was a member of the federal Parliament from 1910 to 1913 and from 1922 to 1949. Scullin led the Labor Party from 1928 to 1935.



James Scullin

Sculpin is a family of fishes that have large mouths, large, flattened heads, and bodies that taper sharply to the tail fin. The fins have well-developed fin rays. They live in many parts of the world, mostly near rocky shores. Some live in deep parts of the ocean, and others live in fresh, inland water.

Most sculpins have spiny heads and fins and warty skins. People in the Arctic regions eat them, although these fish have little flesh and many bones. The sculpins eat small sea animals, and have greedy appetites. They often steal the bait from fishhooks. Sculpins are eaten by larger fish. The *miller's thumb* or *bullhead* is a 10 centimetre long sculpin that lives in fresh water—usually clear, flowing streams with pebbles.

Scientific classification. Sculpins make up the sculpin family, Cottidae.



A Greek god, either Poseidon or Zeus (detail)
Greece, about 460 B.C. Bronze. Figure 2.08 m high.



The Hindu goddess Durga
India, A.D. 600's. Stone. 1.50 m high.

Sculpture

Sculpture is one of the most complex of the arts. Although the word *sculpture* originally meant *cut* and implied the technique of carving, modelled objects are also called sculpture. Examples of sculpture range from Michelangelo's powerful carvings to African ceremonial masks, and from stone statues that decorate cathedrals to metal mobiles that sway gracefully in the air.

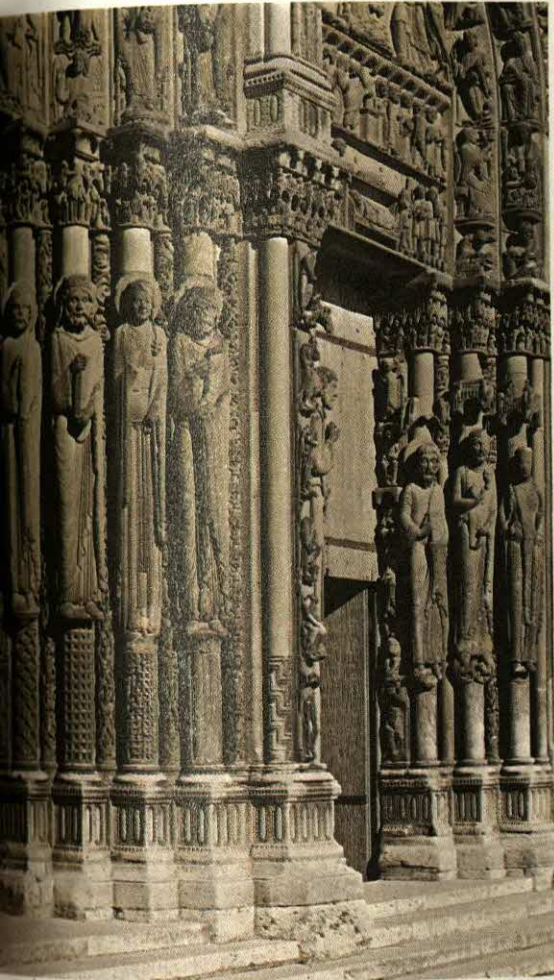
A piece of sculpture can be small enough to stand on a table, or as large as an Indian temple. Much sculpture tends to have a *monumental* quality—the quality of grandeur and nobility in a work of art. Sculpture may also be intimate, intricate, or disturbing. Large-scale sculpture is often called monumental because of its size. Yet even the smallest piece of sculpture has the power to express noble and grand ideas.

The art of sculpture probably developed in association with religious and magical practices. Sculpture

emerged as an art form about 20,000 years ago, during the Palaeolithic Period (Old Stone Age). Prehistoric people carved small statues from such materials as bone or ivory. They probably used these carvings in burial or fertility ceremonies. They modelled similar objects in clay.

The importance of sculpture

As a record of history. Sculpture is extremely valuable for the information it can supply about the development of human culture. Sculpture can tell us much about the way of life of a particular people or period by physically representing the ideas and ideals of a civilization. For example, the ancient Greeks and the people of the Middle Ages both idealized the human form in their sculptures and showed the human body as they felt it should look. The Greeks admired humanity and its works, and they tried to make the human form as perfect as possible in such sculptures as the figures of the *Greek god Poseidon* or *Zeus* (shown on this page). During the Middle Ages, people were more concerned

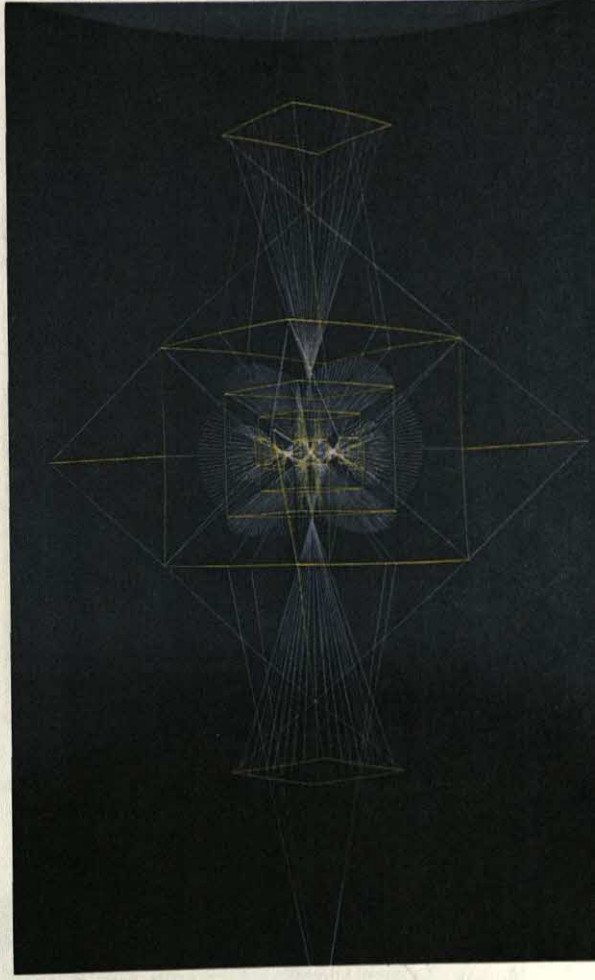


West portals of Chartres Cathedral (detail)
France, about 1150. Stone. Figures 6.25 m high.

with life after death than with life on earth. Sculptors of the Middle Ages made the human form longer and thinner than real men and women in an attempt to create a feeling of spirituality. An example of this highly religious medieval style appears in the long, exaggerated figures that decorate the *west portals of Chartres Cathedral*. These figures, shown on this page, represent characters from the Old Testament.

The Aztecs of Mexico created a grim, sacrificial art dominated by religious ideas. *Xólotl*, an Aztec death god, appears as a skeletal figure because the Aztecs believed that this god, in the form of an evening star, guided the dead through the underworld (page 188).

In India, China, and other Asian civilizations, sculpture is used to aid contemplation. Such Asian religions as Buddhism and Hinduism stress the eternal, invisible powers of the universe rather than the temporary, observable realities of the everyday world. One way to seek to understand these divine powers and to become united with the eternal is through contemplation of



Variation Number 7: Full Moon by Richard Lippold
U.S.A. 1949-1950. Brass rods, nickel-chromium and stainless steel wire. 3.05 m high.

sculptured images. Much Indian sculpture is devoted to images of Siddhartha Gautama, known as Buddha, the founder of the Buddhist religion. Indian sculptures that decorate Hindu temples show the power of the divine as it flows from the heart of the temple outward into the world. The stone carving of the *Hindu goddess Durga*, shown on page 186, represents the goddess killing the buffalo demon, a legendary triumph of good over evil.

Some modern artists create sculptures that comment on the ideas, ideals, and social issues of their society. The modern American artist Judy Chicago dealt with feminist concerns in *The Dinner Party* (page 188). The work consists of a table with 33 individually designed place settings that symbolize 33 historically important women.

Sculpture also provides us with a record of the everyday life of a particular culture. Because much sculpture is extremely durable, it has survived as a major source of our knowledge about such ancient cultures as Egypt, Babylonia, Mesopotamia, Assyria, and Persia. For exam-



Xólotl, an Aztec death god
Mexico (Aztec style), A.D. 1324-1521. Jade. 28 cm high.

ple, the linen clothing portrayed in the sculpture *Egyptian Soldiers Leading Prisoners* (this page) tells us that the Egyptians were farmers who grew cotton and flax. The artists of western Mexico constructed delightful scenes in clay that illustrate various aspects of village life. The *model of a ball court with spectators* (this page) represents a game known from the Arizona region of North America to the Caribbean. The game was not merely entertainment. It was also a ceremony that reenacted the daily disappearance of the sun into the under-



Egyptian Soldiers Leading Prisoners
Fragment of a relief from the tomb of the Egyptian king Horemheb.
Egypt (Dynasty XVIII), about 1330 B.C. Limestone. 62 cm wide.



The Dinner Party by Judy Chicago
United States, 1979. Mixed media. 14.6 m by 14.6 m.

world, and implied the sun's return. Thus, the ball game was a symbol of the renewal of the universe.

As monuments and memorials. Because sculpture can be created from such long-lasting materials as stone or metal, it is the art form most suitable for monuments and memorials. This type of sculpture is called *commemorative sculpture*. In some civilizations, most commemorative sculpture represents important people or great events. For example, the Maya of Mexico and Central America carved stone pillars called *stelae* that they erected in their city plazas. A stela commemorated important events in the life of a ruler as well as significant dates in Maya history. The Romans created *Trajan's Column* (page 189) as a sculptural record of the Emperor Trajan's victory over Dacia in eastern Europe during the early A.D. 100's.

In the former Soviet Union, where people of many cultures were under Soviet rule, commemorative sculpture had an additional purpose. The Soviet government used such war memorials as Russia's *The Motherland* by Yevgeny Vuchetich as landmarks to give the people a



Model of a ball court with spectators
Western Mexico (Nayarit style), about A.D. 100-600.
Clay. About 30 cm high.



The Motherland by Yevgeny Vuchetich

Part of a memorial, made up of several sculptures, in honour of the heroes of the Battle of Stalingrad. Volgograd (formerly Stalingrad), Russia, 1967. Reinforced concrete. About 82.30 m high.

sense of belonging to one culture. Vuchetich's sculpture is illustrated on this page.

As artistic expression.

Many artists create sculpture to satisfy their creative need to communicate, to express their own ideas and feelings, or simply to create an object of beauty. When we look at a piece of sculpture, we can ask ourselves: "What is the sculptor saying in this work?" or "Why do I find this work beautiful, profound, or disturbing?"

Much modern sculpture is created partly to satisfy the sculptor's desire to experiment with new forms and materials. Many sculptors of the 1900's have been more interested in pure form—that is, the physical shapes of sculptured works—than they are in communicating some idea or theme. For this reason, many modern sculptures are *abstract* or *non-representational*, which means they have no recognizable subject matter. *Bird*

in Space (page 216) shows the interest of the Romanian-born sculptor Constantin Brancusi in such elements as balance and the treatment of surface. Modern sculptors often use stainless steel, plastics, aluminium, glass, or other industrial materials. They try to develop the unique qualities and emphasize the beauty of these materials, as the American sculptor Richard Lippold did in *Variation No. 7: Full Moon*, a beautiful geometrical construction of tightly stretched wire (page 187).

As part of architecture. Throughout history, sculpture has been closely associated with architecture, partly because similar materials and skills are used in both fields. In the temples of the Middle East, India, and ancient Greece and Rome, and in the cathedrals of Europe in the Middle Ages, the forms of the buildings blend completely into sculpture. This blending can be seen in the heads and bases of columns, the mouldings around doors and along the edges of roofs, and the abstract decorations. In some cases, including the *Kailasanatha temple* at Ellora, India, the temple itself was carved out of solid rock (page 190). All these features show the inter-relationships between sculpture and architecture.

The sculptors of ancient Greece carved their works on panels and *friezes* (horizontal bands) on the sides of these buildings, on *pediments* (triangular segments below a sloping roof), and on *metopes* (square areas above columns).

Occasionally, sculpture that is part of the structure of

Trajan's Column (detail)

Relief showing Trajan's campaign against the Dacians. Rome, A.D. 113. Marble. Relief band about 1.27 m high.





Kailasanatha Temple
Ellora, India, begun A.D. 700's.
Carved out of solid rock.

a building also performs a function. For example, Greek sculptors made columns in the form of clothed female figures called *caryatids*, which actually hold up part of the building. A famous group of caryatids was used to support the south porch of the *Erechtheum* (this page) on the Acropolis in Athens. Many medieval cathedrals have decorated waterspouts called *gargoyles*. The decorations consist of grotesque figures of animals or human beings (see *Gargoyle*).

Sculpture as an art form

Kinds of sculpture. The most familiar kind of sculpture is called *sculpture in the round* or *free-standing sculpture*. It is modelled or carved on all sides. A sculpture in the round can have a main view, giving it a "back" and a "front," as in certain sculptures of the human figure. Or it can be completely finished on all sides so that

it can be viewed with pleasure from any angle, as can much abstract sculpture. In the past, some sculpture in the round was meant to be seen only from the front. The artist left the back of the figure rough and unpolished, with tool marks showing. This practice has provided much information about the methods of these sculptors.

Sculpture in the round varies greatly in size and scale. Some statues are life-sized or larger. Statues that are somewhat larger than life-sized are said to be in *heroic* scale. If they are from several to many times larger than life-sized, they are in *colossal* scale. Two ancient examples of colossal sculptures were the statue of Zeus in Olympia, Greece, and the Colossus of Rhodes near the harbour of the island of Rhodes. Re-creations of both works appear in the *Seven Wonders of the Ancient World* article.

Sculpture that is completely attached to, or absolutely part of, a flat surface is called *sculpture in relief*. There are two kinds of relief work—*true relief* and *intaglio*. In true relief, the figure stands out from the surface, as in *Lion fighting a bull* (page 195). In intaglio, the figure is carved into the background, as in the *seal carved with the figure of a unicorn* (page 197). True relief may be either *high relief* (in which the carving is cut deeply) or *low relief* (in which the carving is shallow). Low relief was used by the ancient Egyptians for decorating the massive outside walls of their temples. This kind of relief is best seen in strong light, which makes the outlines of the figures stand out as sharp shadows. *Egyptian Soldiers Leading Prisoners* is an example (page 188). See also *Relief* (picture: A low relief).

Relief sculpture can be carved or modelled. Some of the early carved reliefs of the Egyptians are little more than engraved lines on stone. Many Greek reliefs are shallow, but they stand up from a flat surface in true relief. In some reliefs, the Greeks flattened off the forms nearest the viewer, and deeply undercut and rounded the forms at the back. Later Greek and Roman reliefs tend to have the nearer forms rounded. The high-relief figures seem almost detached from the background,



Caryatids from
the south porch of
the Erechtheum
Greece, about 421-about 406 B.C.
Marble. Figures 12.29 m
high.

as in the *Alexander Sarcophagus* (page 207).

Reliefs can also be modelled in clay or wax and cast in bronze. Two famous examples of cast reliefs are the doors for the Florentine Baptistery by the Italian Renaissance sculptor Lorenzo Ghiberti, and the new doors for Saint Peter's Basilica in Rome by the modern Italian sculptor Giacomo Manzù. See **Relief** (picture: High-relief figures).

Form and treatment. Sculptors use many elements found in painting. These elements include space, mass, volume, line, movement, light and shadow, texture, and colour. But a painting has only two dimensions—height and width—because it is created on a flat surface. The painter can give only an illusion of depth. By contrast, sculptured forms have three dimensions. They have depth, or solidity, as well as height and width because the sculptor creates the forms in space. The terms *mass* and *volume* are used to describe the way sculptured forms occupy space. Mass describes the amount of bulk, solidity, or weight of a form in space. Volume refers to the amount of space occupied by a sculpture. *Line*, or the edges or contours of a sculpture, encloses or defines the shape of the sculptured form.

Movement is an important element of sculpture. Some sculptures seem to be completely at rest and suggest little or no movement. For example, the bronze statue of the *Charioteer of Delphi* (this page) has a simple outline. It appears powerful, solid, and calm. It stands firmly on its base, in complete balance. This kind of sculpture is called *static* (unmoving).

Sculpture that gives an impression of change, movement, and energy is called *dynamic*. Sculptors can create the illusion of movement in several ways. In *Unique Forms of Continuity in Space* (this page), the Italian sculptor Umberto Boccioni created rhythms within the statue itself through the repetition of curved shapes. The figure seems to hurl itself through space in successive stages of continuing movement. Antoine Coysevox, a French sculptor, showed a figure in vigorous action in his statue of *Mercury* (page 213). When we look at such a figure, our eyes follow the lines of the body and the limbs. These lines lead in many directions, creating a feeling of movement.

Some sculptures actually do move. These works are called *kinetic* sculpture. Among the most original kinetic sculptures were the *mobiles* invented by the modern American sculptor Alexander Calder. As in *Red Petals* (page 192), the various elements of most of Calder's mobiles are made of thin sheet metal. Some suggest swimming fish or leaves blowing on a tree. The metal shapes are linked by rods and wires to form a series of balanced pairs that are suspended from a single point. They rotate about each other in the lightest breeze.

Some artists build kinetic sculptures in which the various parts move mechanically. The modern French sculptor Jean Tinguely became famous for his complicated structures created out of scrap metal. They have mechanically moving parts that actually break apart, turning the sculpture into scrap once more.

Light and shadow. A painter indicates form by creating light and dark shades. After this shading is completed, it cannot be changed. A sculptor creates an actual three-dimensional object that must depend on changeable natural or artificial lighting. Thus, the sculp-



Charioteer of Delphi
Greece, about 475 B.C. Bronze. 1.80 m high.



Unique Forms of Continuity in Space
by Umberto Boccioni
1913. Bronze.
1.10 cm high.



The Arts Club of Chicago

Red Petals by Alexander Calder

1942. Painted metal and wire. 2.59 m high.

tor may have a conception of ideal lighting conditions for a particular work.

Texture. Because of the natural play of light and shadow, the sculptor also must consider the texture of the forms. The sculptor must decide whether to leave the surface of the work rough, or how far to go in giving it a smooth, highly polished surface. A rough surface, such as one showing the sculptor's hand marks or tool marks, catches light and can give the sculpture a feeling of strength and power. A smooth, highly polished surface can make the work seem impersonal. Compare the French sculptor Auguste Rodin's bronze *Orpheus* (page 214) with the American sculptor David Smith's stainless steel *Cubi XIX* (page 217).

Colour. Much sculpture is left the colour of its material, whether it is bronze, marble, or wood. Many sculptors and patrons prefer the natural beauty of such materials. However, there is a long tradition of colouring sculpture. To make their works more lifelike, sculptors in ancient Egypt, ancient Greece, and other early cultures painted the lips, skin, eyes, and hair of their subjects. Unfortunately, the colours have faded from most surviving sculptures of ancient Egypt and Greece. Many African and American Indian sculptures gain emotional intensity from their colouring. Examples include the *Royal throne* (page 202) from Cameroon.

Today, many artists use colourful synthetic materials or complete their works with colour. An example is *Woman with Suitcases* (page 217) by the American artist Duane Hanson. The work is made of fibreglass and polyester combined with real-life accessories such as luggage and clothing.

Colour can make heavy materials seem lighter, create a happy or gloomy mood, or make a sculpture resemble a painting created in three dimensions. Complicated forms become easier to understand.

The sculptor at work

Carving and modelling are the basic techniques of sculpture. In *carving*, a sculptor works with a solid block of wood, stone, or some other material. The sculptor visualizes the finished figure and then cuts and chips away the material until only the imagined figure remains. In *modelling*, the artist builds up the sculpture by adding layers of clay, wax, or some other soft, pliable material that will stick to, and blend with, itself.

Because the materials used in modelling are impermanent, most modelled sculpture is turned into a more lasting form. From the earliest times, sculptors have preserved clay figures by baking them until they are hard. Figures made in this way are called *terracotta*, an Italian term meaning *cooked earth*. Usually, only small figures can be made by this process, and they break easily.

A common way to make a modelled sculpture permanent is to *cast* it in metal or another hard material. First, the artist makes a mould of the modelled work. Into the mould, the artist pours a more permanent material—cement, bronze, or aluminium, for example—and lets it harden. As long as the mould lasts, any number of replicas of the original can be cast. See **Cast and casting**.

The first sculptors. People of the Stone Age used sharp flint knives to carve wood and bone. On their spearheads they scratched pictures of animals.

Ancient Egyptian sculptors used only simple stone tools skilfully to cut and polish the hardest stones. To make a statue such as *King Mycerinus of Egypt and his queen* (page 196), the sculptor chose a block of stone and trimmed it into a right-angled solid slightly larger than the finished work would be. On each side, the sculptor outlined the figure to be carved. Next, the sculptor removed the excess stone on the corners of the block by crushing it with a stone mallet or a pounding stone. The result was a blocklike figure that needed only to have the edges and corners rounded and details added. The final polishing was done with special hard rubbing stones and a mixture of fine sand and water.

The Egyptians carved wooden figures in the same way. The sculptor gave the finished wood figure a thin coat of plaster or *bitumen* (a tarlike material). Then the artist painted it in bright colours and *gilded* it (coated it with a thin layer of gold).

Middle Eastern artists worked with jewellers to make metal sculpture by the *repoussé* process. First, the sculptor carved a wooden pattern. Then sheets of gold or silver were hammered into shape over the pattern. Shields, helmets, and cups were made this way.

Greek sculptors. By the 500's B.C., the Greeks were carving most of their statues from white marble. They used hand tools made of hard bronze and iron. The figure was roughed out with a hammer studded with sharp points. The sculptor used pointed chisels for the finer work. A triangular, pointed tool was used to give a sharp edge to the figure's eyes and lips. The sculptor also used specially shaped tools to cut out folds in drapery, in the same way that *flutes* (grooves) were cut in architectural columns.

The Greeks also learned to *fire* (bake) huge terracotta sculptures without having them break. They used this knowledge to cast life-sized or larger bronze figures of people and animals.



Modelling. A sculptor builds up a figure with small pieces of clay. A permanent bronze cast will then be made.



Carving. This sculptor uses a hammer and chisel and other special tools to trim the block of marble to the desired shape.



Welding is a method of creating metal sculptures through the use of such equipment as arc welding tools, above.

When casting a smaller sculpture in bronze, the sculptor first modelled the work in wax. The wax figure was dipped in a *refractory mixture* (a kind of clay mixture), and then fired. As the figure baked hard, the wax melted and drained out, leaving a hollow mould in the shape of the original figure. The sculptor then poured liquid bronze into the mould. This casting process is called *cireperdue*, a French term meaning *lost-wax*. It has been used throughout the world.

Roman sculptors. To meet the large demand for portrait busts, the Romans developed a set of standard symbols for hair, eyes, nose, and mouth. A student learned to carve by reproducing these details accurately, rather than by copying a living model. These symbols were then modified to produce a likeness of a particular individual.

Medieval and Renaissance sculptors used the same methods and tools as did ancient sculptors. Medieval sculptors also used specially shaped tools for wood carving, which resulted in highly intricate work.

During the 1400's and 1500's, Renaissance sculptors rediscovered the techniques of large-scale bronze casting, and produced giant *equestrian monuments* (figures on horseback). Machines were developed to help enlarge the models. This led to the development of carving machines that copied and enlarged stone sculpture entirely mechanically. The carving machines were used for a short time during the 1700's and 1800's.

Sculptors today. For centuries, sculptors trained as apprentices in workshops. Today, they train in art schools or universities. Most prefer to work alone or with one assistant rather than in a workshop.

Modern sculptors commonly use such industrial materials as stainless steel, aluminium, plastics, and neon lights. They also use scrap and discarded materials such as old wood or machine parts. The sculptor assembles these materials with glues, power saws, drills, and hammers. Such works are called *assemblages*.

Today, few sculptors carve in wood or stone. Carving is strenuous and time-consuming. Modelling is much faster, cheaper, and more flexible. Modellers use soft materials such as wax, wet plaster, or clay. Their main tools are their hands, but they also use trimming and shaping tools. Soft clay and wet plaster cannot support their own weight when they are drawn into thin shapes. Modellers overcome this situation by building a framework called an *armature* to support the figure. An armature consists of wire for small figures, and metal tubing or wood for large figures. To give the sculpture permanence, a casting must be made. This is a highly specialized and expensive process that few sculptors are equipped to do themselves. Most of them make a *maquette* (model) and take it to a foundry where an enlarged copy is cast under the artist's supervision.

Because of the difficulties of casting, many sculptors work metal by hand. With such modern industrial equipment as electric arc and gas welding tools, an artist can cut and shape metal and join the pieces together. To finish their sculptures, modern artists use such industrial equipment as sandblasting machines or grinding tools. They can produce a *patina* (surface film) on bronze by applying heat and various chemicals. This treatment changes the natural shine and golden colour of bronze to reddish-brown, green, or black.

Beginnings

Prehistoric sculpture. People of the Stone Age recognized the forms of living things in such objects as bones, animal horns, and rocks. Prehistoric sculptors carved eyes or arms and legs in these objects to make them look like people or animals. There were only a few subjects of prehistoric sculpture. The figure of *A bison with turned head* (this page) and other animal sculptures probably represented animals killed by hunters. Figures of a plump woman, such as the figure known as the *Venus of Willendorf* (this page), may have represented the Mother Goddess, who gave life to the people and the plants and animals they lived on.

After prehistoric peoples learned to make pottery vessels by firing clay, they used this technique to make figurines. Terracotta figurines have been found in many parts of Egypt, Asia Minor (present-day Turkey), Mesopotamia (parts of modern Syria, Turkey, and Iraq), and the Indus Valley (now Pakistan and northwestern India). Although few details appear on these figurines, prehis-

toric sculptors obviously did try to emphasize such important physical features as an animal's strong horns or neck, or a goddess's breasts and buttocks.

Beginning about 3000 B.C., ancient civilizations produced many fine sculptures. By this time, artists had gained skill at working with such harder materials as stone and metals.

Middle Eastern. Most early Mesopotamian sculpture consists of small-scale male and female figures, such as kings, priests, or deities. Sculptors showed their subjects in stiff poses and did not attempt to suggest movement or to portray actual people. Livelier scenes of everyday life appear mainly on stone reliefs decorating containers, furniture, and other objects.

During the era of the Assyrian Empire (900's B.C. to 600's B.C.), sculpture was used mainly as architectural decoration. The Assyrians carved colossal stone figures of bulls with human heads to stand beside palace gateways. Palace walls were decorated with reliefs made up of many scenes. These scenes told the story of complete military campaigns and other important events. Some of



Venus of Willendorf
Willendorf, Austria,
30,000-25,000 B.C.
Limestone. 11 cm high.
Naturhistorisches Museum,
Vienna, Austria

Stele of Ur-Nammu (detail)

Relief showing Ur-Nammu, king of the Sumerian city-state Ur, pouring a libation before the goddess Ningal. Mesopotamia, about 2113-2096 B.C. Limestone. Figure of king about 38 cm high.



Musée des Antiquités Nationales, St-Germain-en-Laye, France

A bison with turned head

From the cave of La Madeleine in the Dordogne Valley, France, about 9000 B.C. Reindeer antler. About 10 cm high.





Lion fighting a bull

Relief from the stairway to the Audience Hall of Darius I at Persepolis. Persia (Achaemenid Empire), about 500 B.C. Stone. Figures over life-size.

the finest relief carvings are those from Nineveh (an Assyrian city in what is now northern Iraq), showing a royal lion hunt. Assyrian sculptors chose to carve the movements and forms of animals more accurately and realistically than earlier sculptors did. But their human figures were stiff and unemotional, both in relief carvings and in the few large figures that they carved in the round. For examples of Assyrian low-relief carving and sculpture in the round, see the article *Assyria*.

Persian sculptors of the Achaemenid Empire, which covered much of the Middle East and southwestern Asia from the 500's B.C. to the 300's B.C., also were interested in the patterns of animal limbs and muscles. An example of their work is the relief *Lion fighting a bull* (this page). The Persians decorated buildings with large relief sculpture, but their finest work was on a small scale. Some of it shows clear signs of influence from classical Greece. Greek sculptors probably worked for the Persian kings. See *Persia, Ancient*.

The Hittites, who founded a great kingdom in Asia Minor after 2000 B.C., used architectural relief sculpture in a manner similar to the Assyrians. They also carved a number of large monuments from solid rock, showing kings, gods, or religious ceremonies. See *Hittites* (picture: A Hittite banquet).

Aegean. The islanders who inhabited the Cyclades in the Aegean Sea about 3000 B.C. carved figures in white marble. Like the *Cycladic marble figurine* (this page), most of these figures were of women. The sculptors had no metal tools, but they rubbed the figures smooth with pebbles of emery. Archaeologists have discovered most of the figurines in graves.

During the 1500's and 1400's B.C., the Minoans of Crete made superb small figures of worshippers. Some of these figures were made of gold and ivory, and others of terracotta. Still others were cast in solid bronze. The Minoans did not smooth or polish the bronze, so these figures have a rough finish. The figures show a vigour not developed elsewhere at this early date in history. One example is the bronze figure of a *Woman praying* (this page).



Cycladic marble figurine

Cyclades Islands, Greece, about 3000 B.C. Marble. 76 cm high. Ashmolean Museum, Oxford



Woman praying

Crete, Minoan period, 1500's B.C. Bronze. 19 cm high. Staatliche Museen, Berlin

Egyptian. A distinctive style of sculpture developed in Egypt about 3000 B.C. and continued with little major change for more than 3,000 years. Egyptian sculpture was made to commemorate a person or event or to serve as a substitute for the activities of real people.

Commemorative sculpture includes *King Mycerinus of Egypt and his queen* (this page) and other great statues of kings and queens, whom the Egyptians regarded as gods. The colossal seated statues of Ramses II, cut in rock at Abu Simbel, are more than 20 metres high. The Abu Simbel statues are illustrated in the *Ramses II* article. Reliefs covering the walls of temples commemorated religious ceremonies or such events as coronations and military victories. An excellent battle relief is *Egyptian Soldiers Leading Prisoners* (page 188).

Egyptian sculptors also carved stone or wooden statues that were placed in tombs to represent the dead. These reliefs and modelled figures showed scenes of daily life similar to the activities the dead were expected to perform in the next world.



King Mycerinus of Egypt and his queen
Egypt (Dynasty IV), 2613-2498 B.C. Schist. 1.40 m high.

Museum of Fine Arts, Boston, U.S.A.

In carving the human figure, the Egyptians considered realistic scale unimportant. They showed a king much taller than his subjects or his enemies. Fixed rules controlled the proportions of the parts of the body. These rules applied to sculptures ranging from tiny figures to colossal statues carved out of cliffs.

Tradition also required figures to have quiet, restful poses and expressionless faces. The Egyptians considered any vigorous action or realism unnecessary. Only for a short time during the 1300's B.C. did some realism appear in figures and portraits.

Indus Valley. The Indus Valley civilization flourished in what is now Pakistan and northwestern India from about 2500 B.C. to about 1700 B.C. Sculptures have survived from the major areas of this civilization, including such centres as Lothal, Rupar, and Maheshwar. The two main sites of the Indus Valley civilization, however, were along the Indus River—the cities of Harappa in the north and Mohenjo-Daro in the south. Indus sculptures include small stone tablets that were used as seals, and figures of animals, human beings, and deities.

The seals show the rounded forms of bulls, elephants, and rhinoceroses, along with writing in picture-like signs. The illustration of the *seal carved with the figure of a unicorn* shows the delicate intaglio carving (page 197). When stamped in wet clay, the seal created a raised image of itself in the clay.

The limestone *torso of a god* is believed to represent a friendly god (page 197). The rhythmic repetition of the curving lines of the torso shows a love of linear rhythm. Indus sculptors also stressed harmonized forms, as shown in the way the torso is unified by the softly swelling curves of the body. The sculptor has carefully rounded these curves, especially the abdomen. This emphasis on harmonized forms appeared later as a dominant characteristic of Indian sculpture.

The bronze *Statuette of a girl* may represent a dancer who has paused between movements (page 197). The dynamic quality of this sleek figure is partly due to the rhythmic, angular thrusts of her arms, legs, and torso. The sculptor has also indicated movement by contrasting the linear rhythms of the torso and legs against the triangular right arm and the forward left leg. A similar linearity and dynamism characterized much later Indian sculpture.

The peak of Indus Valley sculpture extended from 2500 to 2000 B.C. Sculptors worked in stone, metal, and clay. Stone seals and the few surviving three-dimensional stone sculptures represent their subjects realistically and apparently had religious meaning. See *India, Art of; Indus Valley civilization; World, History of the* (picture: A stone seal).

Asian sculpture

Asian sculpture is made up of diverse artistic traditions separated by time and geography. When connections exist in style or subject matter, they are usually due to the influence of religion, conquest, or trade. For example, Assyria, Mesopotamia, and Persia—the ancient civilizations of west and central Asia—produced monumental figurative sculpture. After the Muslim conquests of the A.D. 600's, figurative sculpture ceased in these areas because Islam prohibited making images of living things. However, Islamic artists carved reliefs of *motifs*

(repeated designs) and *calligraphy* (beautiful handwriting) as architectural decoration. Islamic decorative objects in ivory, metal, and wood have sculptural form.

Traditional Asian sculpture was created primarily to communicate religious and political ideas, for ritual purposes, or to glorify a ruler. Few Asian sculptors are known by name. Sculptors rarely worked alone until the late 1800's. They trained in workshops supported by religious institutions, the ruling classes, and merchants.

India. Sculpture first flourished in India in the 2000's B.C., and that period is discussed in this article in the section *Indus Valley*. Little sculpture survives from the period immediately after the decline of the Indus Valley civilization. The beginning of traditional Indian sculpture can be dated to the 300's B.C. and to the establishment of empires that ruled most of south Asia. Much of India's sculpture was made for religious buildings. Before about A.D. 1200, the main religions were Buddhism, Hinduism, and Jainism. Training in the techniques of sculpture was passed down within the family.

The earliest stone monuments. The Maurya Empire was India's first great empire, and extended over much of the subcontinent. In 261 B.C., the Maurya emperor Asoka vowed to maintain his rule according to the Buddhist rule of piety. To publicize his laws, Asoka had them inscribed on many stone pillars, some 12 metres high. For a picture of the most famous surviving pillar, at Sarnath, see the **Asoka** article. On this pillar, a carved lotus flower symbolizes purity and the emergence of life from the primeval waters. Above it, representations of a

lion, elephant, bull, and horse symbolize power, either of the king or of Buddha (see **Buddha**). The *chakra*, or wheel, symbolizes either the teaching of Buddha, who is said to have set the wheel of law in motion in his teaching, or the king who was called the holder of the wheel in ancient India. On the top of the pillar, four gigantic lions roar out the power of Buddha and Asoka. A huge wheel, now missing, once stood above the lions.

Asoka was also responsible for the building of many stupas and cave shrines, the two main kinds of Buddhist centres.

Stupas. Some of the most magnificent Buddhist sculptures decorate the gateways and stone railings that surround *stupas* (domed funeral mounds). These mounds were built to enshrine the relics of the Buddha or a Buddhist teacher. Relief carvings illustrate the life and teachings of the Buddha. Some of the best preserved early stupas stand at Sanchi in central India. For a description and picture of the Grand Stupa, see **India, Art of (Stupas)**.

Cave temples. From the 200's B.C., artificial caves were carved out of cliffs of solid rock to serve as shrines and monasteries. The 28 caves at Ajanta in western India were created between A.D. 100 and the A.D. 400's. Magnificent sculptures of the Hindu god Shiva were carved in a cave temple at Elephanta, near Bombay, in the 500's. Sculptors worked on the caves at Ellora, near Ajanta, until about 1000. They created Buddhist, Hindu, and Jain caves next to each other. See **India, Art of (Cave temples)**.



Statuette of a girl
Mohenjo-Daro, Pakistan
(Indus Valley civilization),
about 2500-2000 B.C.
Bronze. About 10 cm
high.



Seal carved with the figure of a unicorn
Mohenjo-Daro, Pakistan
(Indus Valley civilization),
about 2500-2000 B.C.
Soapstone. About 5 cm square.



Torso of a god
Harappa, Pakistan
(Indus Valley civilization),
about 2500-2000 B.C.
Limestone. 8.5 cm high.

The early stupas and caves are beautifully carved with scenes from the life of Buddha. The Buddha figure, however, is represented by symbols such as the wheel, footprints, or an empty throne.

The Buddha image. Buddha was not represented in human form until the period from A.D. 1 to 99. Buddha images were first produced in large numbers in two areas of India around 100. One area was Gandhara in the northwest, now part of Pakistan. The other was the city of Mathura, near present-day New Delhi.

Gandharan Buddhist images show influences from Greece and Rome brought by conquest and trade (see *India, History of* [The Persian and Greek invasions]). The Buddha's hair is wavy and his toga-like robes hang in deep, graceful folds. However, the spiritual, introspective power of Gandhara Buddha is very Indian. The Buddha's half-closed eyes and slightly smiling lips suggest inward harmony and transcendence.

In contrast, Mathura figures are much more energetic. The eyes are wide open and the mouth softly smiling. The lines of the body, broad shoulders tapering to a narrow waist, are emphasized rather than the robe. The Buddha's power is symbolized by his physique and by the lions that support his throne. In the Mathura Buddha, the broad chest and swelling stomach (bulging around a deeply sunk navel) are a way of showing the breath, or life force, within. In the Western tradition, sculptors tried to make stone true to life by carving a hand, for example, to show the bones and veins through the skin. In India, a beautiful body was considered to be perfectly smooth. Bones and veins were only shown in images representing starvation, torture, or death. This wholly Indian ideal of beauty, statuesque and sensuous, underwent only slight modifications during subsequent periods of Indian art.

A sculptural style emerged in India that spread across Asia with Buddhism and through Hindu traders and merchants. This style was stimulated by religious doctrine, particularly the *bhakti* (worship) cults. These cults required narrative reliefs of Buddhist legends as well as ornamental imagery to decorate both nonreligious and monastic religious sites. Icons of Buddha or the Hindu gods was made according to strict laws of proportion and form.

The first stone images of the gods and goddesses of Hinduism and Jainism appear at about the same time as the Buddha images. The same workshop probably made images for all three religions.

Buddhist art dominated the period from about the 100's B.C. to about the A.D. 500's. The Gupta dynasty lasted from about A.D. 320 to 500. The 400's and 500's marked a classical phase in Indian sculpture. Figures became more pliant and followed a purely mathematical system of proportions. The detailed, yet restrained Hindu and Buddhist sculpture of the Gupta period became the model for later Indian art. The Buddhist stupa at Sarnath dates from this period (see *India, History of* [picture]). Gupta sculptors made images of extreme sensual beauty and hair-raising horror. They could also suggest contradictory qualities in their work. For example, the sensuous Gupta Buddhas with their full lips and eyes like lotus buds are, at the same time, profoundly spiritual.

Hindu sculpture. As Hinduism grew in popularity, so

Buddhism in India declined. Much of the greatest Indian sculpture from the 400's until the Muslim conquest in about 1200 was made for Hindu temples (see *India, Art of* [The Middle Ages]).

One of the finest Gupta sculptures to survive is the Dashavtara temple at Deogarh in central India. On one side of the temple is a beautifully carved doorway; each of the other sides has one large sculptural image. The south wall shows the god Vishnu sleeping on a hundred-headed serpent in the ocean of eternity. In Hinduism, the world is created, passes through many aeons, and is then destroyed, only to be created once more. Between creation and destruction, Vishnu sleeps. The problem for the sculptor is to show the god at rest and still convey his majesty, power, and benevolence. For a picture of this sculpture, carved about 425, see the *Gupta* article.

The most sacred image in a Hindu temple stands in a small, dark shrine at the heart of the temple. Hindus believe the power of the deity flows from the heart of the temple outward: the single large sculptures on the outside walls transmit the power of the indoor image to the world. As temple design developed, the number of sculptures on the outside multiplied until the entire outer walls of the temple were covered with sculpted figures, each one intended to transmit divine power.

Different styles of sculpture developed in the north and south. Sculpture in the north was angular and decorative because the local sandstone could be carved into complex shapes. In the south, especially in Tamil Nadu, sculptors had to work most often in granite. Their



Cleveland Museum of Art, Cleveland, USA

Seated Sakyamuni

Mathura, India (Kushan period), about A.D. 100. Red sandstone. 51.4 cm.



Los Angeles County Museum of Art, U.S.A.

Shiva as Nataraja, Lord of the Dance

Tamil Nadu, India (Chola dynasty), A.D. 900's. Bronze. 76 cm high.

works, therefore, had simpler lines and round flowing forms. Many distinctive regional styles developed within these broad divisions.

During the 600's and 700's, a group of temples were carved out of gigantic outcrops of rock at Mahabalipuram, in southern India. One huge boulder depicts the Descent of the Ganges River. The river banks are crowded with saints, pilgrims, and a variety of animals. A family of elephants is almost lifesize. Water once flowed from a tank at the top of the rock to suggest the river itself. For a detail of this work, see *India, Art of* (The Middle Ages).

Ancient Hindu temples in northern India have tall, sculpted towers with curving sides that taper at the top. In southern India, the gateway towers of Hindu temples rise in rectangular pyramids made of steplike blocks of stone. Each step tells in sculpture a story about Hindu gods. The temple dedicated to Shiva at Ellora, dating from the mid-800's, was carved out of the cliff like a giant piece of sculpture (see *India, Art of* (picture: The Kailashanatha Temple)). This temple shows the influence of the Mahabalipuram sculptures.

Hindu and Jain temples in Khajuraho, central India, were built in the same style between the mid-900's and the late-1000's. They rise from high bases to a series of high peaks. From a distance they resemble a mountain range. The walls and towers are covered with hundreds of sculpted figures of gods, goddesses, people, and beasts.

The Cholas, who reigned in Tamil Nadu from the 900's to the 1200's, built huge, finely finished temples. They were also famed for magnificent bronze sculptures cast using the lost-wax process, a method used in southern India since the 500's. They created groups of figures, depicting the gods, especially Shiva or Vishnu, with their families and companions.

A frequent theme was Shiva, the Hindu god of de-

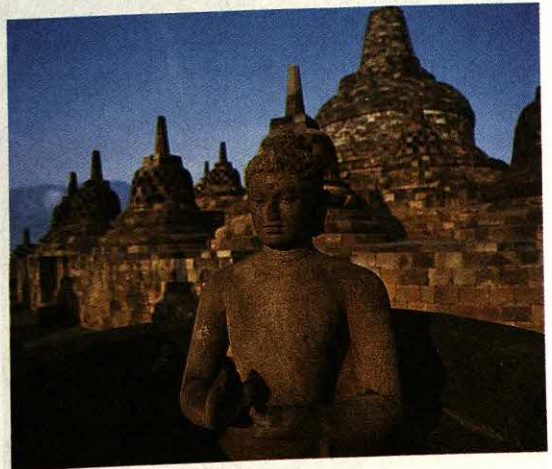
struction, portrayed as Nataraja, Lord of the Dance. The *Dancing Shiva* image on this page was made by a Chola sculptor. Shiva's four arms symbolize his power over north, south, east, and west. Like the image of the sleeping Vishnu at Deogarh, the subject of this work is not only Shiva but also time. Between the destruction and creation of the universe, nothing exists. The first sound in this nothingness is the beat of Shiva's hourglass-shaped drum. Then Shiva begins to dance. The energy of his dance creates the universe. He dances on a dwarf symbolizing ignorance. The power of his dance brings knowledge in its place. At the end of time, Shiva's dance becomes all-consuming and, by the flame he holds in his upper left hand and those that surround him, all existence is destroyed. Then there is nothing, until Shiva again begins to beat his drum.

For an illustrated discussion of Hindu and Jain temples, see *India, Art of* (The Middle Ages).

Islamic influence. In 1191, the first of many dynasties ruled by Muslim sultans captured Delhi and, from there, governed northern India. Islam, the Muslim religion, prohibits making images of human or divine figures or of animals. Muslim patrons hired Indian sculptors to decorate mosques and other Muslim buildings with relief *motifs* (repeated designs) of geometric patterns, flowers, leaves, and ornate inscriptions.

During the period of Muslim rule, Hindu and Jain sculptors continued to decorate their own temples with figurative sculpture. The white marble Jain temples at Mount Abu were built during the 1100's and 1200's (see *India, Art of* (picture: Mount Abu)). Magnificent Hindu temples were built in Vijayanagar in the 1500's (see *Vijayanagar Empire* (picture)).

Colonial and modern. The British, who ruled parts of India from 1757 to 1947, introduced new styles of art and architecture. Until the mid-1800's, Indian sculptors worked in the Western classical style on British government buildings. In the late 1800's and early 1900's, a style known as *Indo-Saracenic* was developed. The basic design was Western, but incorporated such Indian features as domes, kiosks, and finely carved stonework. See *Bombay* (picture: The Gateway of India).



Borobudur

Temple complex showing seated Buddha. Indonesia, late 700's-800's. Stone.

In India today, there are sculptors working in Gujarat, Rajasthan, Tamil Nadu, and elsewhere who trace their families back to the great temple builders of the past. They continue to decorate temples with sculpture using traditional methods. Other sculptors produce works which exhibit the methods, materials, and outlook of the present day, while retaining an Indian identity.

Southeast Asia. Beginning in the 200's B.C., traders and missionaries carried Indian culture to the nations of the Indian Ocean. These countries included Sri Lanka, Burma, Thailand, Cambodia, Java, Malaya, and Sumatra.

The relief carvings of Angkor Wat and other Hindu temples of Cambodia are of greater size and scale than any structures achieved in India. Borobudur, in central Java, was a great monastic and pilgrimage site. The temple complex resembles an architectural mountain and was created to symbolize the Buddhist universe. Its sculptures, carved in volcanic stone, express serenity and harmony in their treatment of the human body. See **Angkor; Architecture** (picture: Angkor Wat); **Indonesia** (picture: The Buddhist Kingdom).

Sri Lanka. Buddhism is thought to have been brought to Sri Lanka in the 200's B.C. by the son of the Indian emperor Asoka. The ruins of the ancient cities of Anuradhapura and Polonnaruwa in northern Sri Lanka include temples, palaces, monasteries, and stupas that surpass in artistic achievement many similar structures in India.

The sculpture of Sri Lanka is usually grouped into three periods. In the earliest period, the main political and religious centre was Anuradhapura. The earliest

stone Buddha images found there date from the A.D. 200's. Metal images found there date from about 500. The figures combine strong Indian influences with local characteristics.

Two types of Buddhist sculpture which are distinctly Sri Lankan are nagas and moonstones. *Nagas*, the door guardians that stand outside stupa complexes and temples are part serpent and part human. Graceful cobra hoods arch behind their heads and they carry large jars symbolizing prosperity and good luck. *Moonstones*, named after their semicircular shape, form the threshold of religious buildings. They are skilfully carved with bands of animals and plants.

The next period of sculpture centred on Polonnaruwa. The capital was moved there when the Sri Lankan rulers were beaten by the Chola kings of south India. The Sri Lankans won back their kingdom in 1070, and kept the same capital. Both Hindu and Buddhist works from this time show the influence of Chola art. By the 1100's, sculpture was more distinctly Sri Lankan. The Polonnaruwa monastery known as Gal vihara has a granite image of the Buddha which is nearly 17 metres long.

The last great ancient kingdoms of Sri Lanka were located at Kotte and Kandy. Sculptures were made in wood, stone, and metal, but some of the finest works were made in ivory. Ivory carvers produced figures of the Buddha and nonreligious works such as boxes and portrait figures of court officials. The descendants of these ivory workers still work in Sri Lanka. Modern metal sculptors have experimented with modern expressions using traditional materials and methods.

China. Chinese sculpture began with human and animal figures in clay and stone in the Neolithic Period (about 8000 B.C. to 3000 B.C.). Sophisticated ceramic vessels with painted, inscribed, or applied decoration appear in the same period throughout what is now China. These containers apparently were ritual vessels.

During the Shang dynasty (about 1766 B.C. to 1122 B.C.), skilled craftworkers used a new medium—bronze—and a new technology—metalworking. But Shang bronzes retained the forms and functions traditionally associated with pottery. The vessels were produced by a unique process called the *piece-mould method*. Artists made models of clay and then a clay mould of the modelled work, into which bronze was poured. The outer mould was made of separate pieces rather than a single unit. Because the mould had to be destroyed to free the vessel, the object could not be duplicated. See **World, History of the** (picture: A bronze ceremonial vessel).

Shang dynasty sculptors made elaborate bronze vessels for rituals of ancestor worship. Realistic and stylized motifs of human images and animals decorate these ritual containers. The animal motifs include buffaloes, serpents, dragons, and tigers. Bronze vessels for wine and grain were made in fantastic shapes with beautiful surface patterns. These vessels dominated Chinese sculpture from the Shang dynasty to about 200 B.C. Sculptors also worked in stone, bone, jade, ivory, clay, and wood during this period. For examples, see **Bronze; China** (pictures: Chinese ceremonial art).

The life-sized figures in the tomb of Emperor Shi Huangdi near Xi'an, China, reveal monumental figure sculpture in China at least as early as the 200's B.C. See



Seated bodhisattva
China. A.D. 530. Limestone. 196.2 cm

Museum of Fine Arts, Boston, U.S.A.



Kyongju National Museum, South Korea

Buddhist triad

Excavated from Anap-chi Kyongju, South Korea, late 600's-700's. Bronze.

Archaeology (picture: An army of life-sized statues); **Singapore** (Religion) (picture: The oldest Hindu temple in Singapore)).

Interaction with other cultures, including Buddhism, during the Han dynasty (202 B.C. to A.D. 220) contributed to the rise of monumental figure sculpture. During the period called the Six Dynasties (A.D. 220-589), Chinese sculptors transformed the swelling, round forms of Indian rhythmic carvings into two-dimensional linear carvings in stone and bronze. Deities once portrayed as nude were clothed and their facial features simplified. In east Asian Buddhism, spiritual guides called *bodhisattvas* became the focus of popular devotion. A *bodhisattva* is an individual who puts off personal salvation to help humanity. The *Seated bodhisattva* (this page) is dressed in the fine clothes of a prince. His body has disappeared beneath ribbonlike scarves and cascading drapery. The statue follows some conventions of Indian Buddhist sculpture, but the Chinese artist changed the way the figure is portrayed. See **China** (Sculpture and pottery [pictures: Chinese sculpture]).

The Tang dynasty (618-907) carried the International Style of Buddhist art from central Asia to Japan along the silk trade routes and by conquest. Tang sculpture became renowned for its realism. Buddhism ceased to be a major artistic force in China by the Yuan dynasty (1279-1368), and sculptural styles became static. Sculptors created small decorative works in ceramics, wood, and jade and other semiprecious stones in a style that continued with little variation to the 1900's.

Korea. Metalworking and ceramic artistry in Korea were heavily influenced by China. Early Korean objects include golden crowns and stoneware vessels from the A.D. 400's and 500's, and porcelains from the 1000's and 1100's. The image-making tradition of Buddhist art inspired monumental figure sculpture in Korea.

The first Buddhist sculptures came to Korea from China, but by the 500's, local sculptors were producing works based on Chinese models. By the 600's, a distinctive Korean sculpture style had emerged in which delicacy and elegant curved rhythms indicate tranquillity and repose. Examples include sculptures found in the Sokkulam cave temple near Kyongju and the gilt bronze *Buddhist triad* (this page). They show how the International Style of Buddhist art, a realistic style that flourished in the late 600's and 700's was adapted in Korea. The rounded modelling of the figures reveals the tremendous influence of Buddhism on east Asian sculpture. See **Religion** (picture: A Buddhist).

Japan. The Jomon, an early Japanese culture of the Neolithic Period, made expressive vessels and figurative sculpture in clay. By the A.D. 200's, Japanese metalworkers cast ritual bells and decorated mirrors in bronze. Sculptors also made clay figures of people and animals, called *haniwa*, as funeral art for the ruling classes.

The introduction of Buddhism in the mid-500's brought the advanced culture of the Asian mainland and a developed sculptural tradition to Japan. The early centuries of Japanese art history reflect a reworking of artistic styles developed in China and Korea. Korean sculptors who moved to Japan produced some of the early masterpieces of Japanese sculpture. One of these sculptors was Tori Busshi, who worked during the early 600's. Japanese sculpture refined a style developed on the Asian mainland. However, even under the cultural domination of China, Japanese sculptors created works of great refinement and beauty.

In response to the realism of the International Style of Buddhist art, a new style of Japanese sculpture arose in the 800's. Sculptors carved images from a single block of wood, and the resulting figures emphasized the block from which they were cut. They had massive proportions, thick facial features, and deeply cut drapery.

By late in the Heian period (794-1185), sculptors responded to the current taste for courtly elegance and refinement. The work of the sculptor Jocho and his studio created the model for subsequent Heian period sculpture. Jocho used a new technique of assembled or joined wood-block construction. He created an idealized style of elegant proportions. Other sculptors of the Heian period represented deities of Japan's traditional Shinto religion in painted wood.

Jocho, who died in 1057, ended the tradition of the anonymous sculptor in Japan. In the succeeding Kamakura period (1185-1338), individual sculptors and their schools became increasingly important. The Kamakura period was the great age of Japanese sculpture. Kamakura sculpture appealed directly to ordinary people and was conservative in style. Portrait sculpture of both real and imaginary subjects, and images of minor deities, exhibit the full power of the new style.

Works by the great Japanese sculptor Unkei, who died in 1223, reveal a realistic technique that characterized his style. In his imagined portrait of the Indian holy man *Asangha* the realistically painted wood is deeply carved to suggest the weight of real fabric. Unkei individualized the figure's features and emphasized the bone structure and muscles. See **Bell** (picture: Japanese temple bell); **Buddhism** (picture: The *Daubutsu* Buddha); **Japan** (picture: Buddhism and Shinto).

African sculpture

African sculpture consists of figures, masks, and other decorated ceremonial and useful objects. Because most African sculptures were made in perishable materials, such as wood, few are over 100 or 200 years old. But works in bronze, ivory, and terracotta may date back several hundred years. Outside Egypt, oldest known African sculptures are terracotta figures created about 500 B.C. in the Nok culture of Nigeria (see Nok). Wood carvings, terracotta works, and bronze castings still are being made in Africa, but increasingly for the tourist trade.

Until the 1900's, Western sculpture emphasized realism. Some African sculptors have shared this interest, but most have deliberately distorted form for expressive purposes. They wanted to produce a visual and emotional response, such as respect, fear, or pleasure. Over time, distinctive regional styles developed that emphasized these characteristics.

Royal and public sculpture. Certain regions in Africa grew wealthy through trade by about A.D. 1000, and complex societies developed that included kingship and elaborate court life. By the 1400's, vast empires south of the Sahara had prospered from control of gold, ivory, and other precious materials. Artists made sculptures, as well as other art forms, to represent and enhance the authority of kings. Their works included portraits of rulers, accounts of mythical or historical episodes, and



Pigorini Museum, Rome

Guardian figure
Kota people, Gabon, 1800's.
Metal. 43 cm high.



Detroit Institute of Arts, Founders Society purchase, Eleanor Clay Fund for African Art

Nkisi
Kongo people, Zaire, 1875-1900.
Wood with screws, nails, blades, and shell. 117 cm high.



Museum für Völkerkunde, Berlin

Royal throne
Bamun people, 1800's.
From the palace at Foumban, Cameroon. Wood decorated with beads.

highly decorative thrones that are closer to sculpture than to furniture. An example is the *Royal throne* (this page) from the palace at Foumban in Cameroon.

Sculptors of the ancient kingdom of Benin in Nigeria used the lost-wax casting process to make splendid bronzes. The people of Benin regarded their king as a god living on earth. In the *altarpiece* on page 213, the king is shown greatly enlarged to signify his political and spiritual power. An attendant on each side of the king suggests the balanced character and good judgment required of a monarch. See also *Antique* (picture: A Benin sculpture); **Benin**.

Today, some African sculpture still is made for public display. Some works play important religious and social roles. For example, in Zaire, Kongo people and their neighbours seal oaths and settle legal disputes by driving blades or nails into a large male figure. This figure, called a *nkisi* (this page), is the residence of powerful spirits. Over time, such a figure becomes a kind of historical record for its village. The materials, facial expression, and pose of *nkisi* figures show their power.

Figures and masks are found mainly in the western and central parts of Africa. Many figures represent ancestors—either the recently dead or the ancient, mythical tribal founders who watch over the well-being of the living. Most masks represent powerful spirits or legendary tribal ancestors. In African villages, masked dancers appear on a number of public occasions. They celebrate harvests, welcome back boys and girls who have gone through religious initiation, and participate in funeral ceremonies. The performance of the dancers is often meant to demonstrate both acceptable and un-

acceptable behaviour, and thus reinforce social and moral values. A *mask* by the We people of the Ivory Coast is shown on this page.

People in Igbo villages in Nigeria sometimes build mud sculpture displays called *mbari houses* as a way to educate young people and remind everyone of common Igbo cultural expectations. Inside each house are dozens of brightly painted figures, many of them life-sized. They show scenes of normal life next to mythic, outrageous, or sexually explicit images. The displays have a moral purpose. They tell stories in which the good are rewarded and those who behave in an unacceptable way are punished. A *mbari shrine* dedicated to the earth goddess Ala is shown on this page.

Personal sculpture. African sculptors often create such useful everyday objects as cosmetics boxes and combs. They even carve decorative geometric designs and tiny animals or human figures on pulleys that are part of weaving looms.

Some personal sculpture has a religious purpose, sometimes to commemorate a death. Twin births occur frequently among the Yoruba of Nigeria. If a Yoruba woman gives birth to twins and one baby dies, she cares for a small wooden figure in memory of the loss. These figures, called *ere ibeji* are a well-known form of African art in the non-African world. Men in Gabon keep the bones of ancestors in a basket or box guarded by a spirit figure or highly abstract head, often made of wood and covered with metal. One such *guardian figure*



Mbari shrine

Featuring the Igbo goddess Ala. Owerri township, Nigeria, 1964. Mud.

is shown on page 202. Ijaw people of Nigeria remember their ancestors with an elaborate three-dimensional memorial screen that depicts the deceased.

African sculpture today. Male artists still make most African sculpture. They make sculpture both for traditional uses and to sell to tourists. The artists learn their skills through an apprenticeship system, studying with an older sculptor until they master the techniques of their art. Many African schools and universities now provide art education similar to that in Europe and North America. As a result, many studio-trained artists, both male and female, produce work more closely resembling that of Western artists. However, the African sculptors often incorporate traditional images or themes into their works.

For additional examples of African sculpture, see **Africa (Arts); Mythology (African mythology); South Africa, Art of.**



Seattle Museum of Art, Seattle, U.S.A.

Mask

We people, Ivory Coast, 1900's. Wood, raffia, cloth, teeth, mirrors, wax, and mud. 81 cm. high.



A royal group

An altarpiece of the Benin people. Nigeria, perhaps dating from the late A.D. 1700's. Bronze, 60 cm. high.

Pacific Islands sculpture

The South Pacific islanders produced sculptures in such extraordinary materials as bark cloth (Melanesia and Easter Island), feathers (Hawaii and New Guinea), cobwebs (New Hebrides—now called Vanuatu), and turtle shell (Torres Strait). Giant stone figures appear in Tahiti; Easter Island; the Austral, Marquesas, and Solomon Islands; and in several areas of Indonesia. Because most Pacific sculptures were made of impermanent materials, most surviving works date from no earlier than the 1800's. The oldest known specimens probably date from the period between 1000 and 500 B.C.

The chief themes of Pacific sculpture involve spirits, ancestors, monsters, and gods important to a local community. For example, the Baining people of New Britain make huge *hariecha* images from bamboo, leaves, and bark cloth—that is, from perishable materials. These images represent friendly spirits which are believed to attend the annual ceremony marking both the harvesting of crops and the initiation of boys into adult society.

The Asmat people of New Guinea carve enormous *bis* poles (below) as memorials to the recently dead. These images are mainly carved when the dead person is believed to be a victim of headhunting or witchcraft. The carvings represent gigantic soul boats that carry the souls of the dead and serve as a pledge of revenge by the living. The rough surfaces and bold, contrasting colours of the poles are characteristic of Melanesian art. Asmat sculptors also were probably influenced by Indonesian art. Soul boats have been an important theme in

Indonesia since the beginning of Bronze-Iron Age culture there about 500 B.C.

In the Sepik River area of New Guinea, the people make masks of monsters and images of demons with extended tongues. An example is *drum decorated with mask and hornbill* (below). The Sepik people believe these masks and figures can drive away evil spirits or harm enemies. The Sepik art style probably was influenced by ideas coming originally from Southeast Asia or southern China, where similar images existed before 200 B.C. Sculptures resembling the Sepik faces are found in the arts of central Borneo and northern Sumatra. The Maori sculpture of New Zealand also shows a similar style.

Maori sculpture ranges from large carved architectural panels to small jade pendants called *hei tiki*. The Maori religion placed many restrictions on the making and use of sculpture. Scholars believe most figures represent honoured ancestors. Lively curved surface decorations reproduce patterns formerly tattooed on the skin. An example is the *Maori post figure* (below).

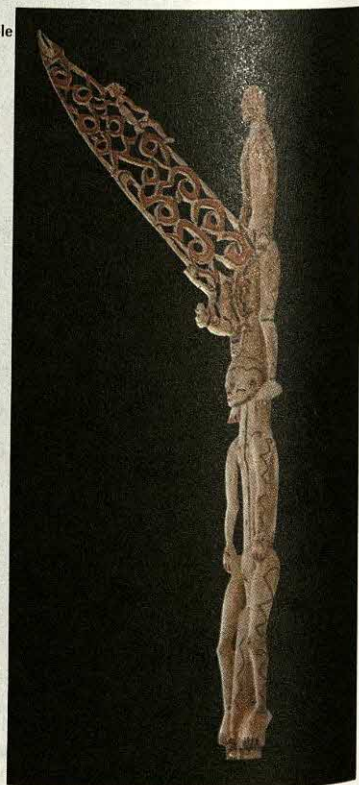
Colour is unimportant in Polynesian sculpture. Instead, artists emphasize dignified, solid forms in space. In a unique image of the Polynesian supreme god *Tangaroa*, the god is shown creating the other gods out of his own body (below). Tangaroa's calm, motionless posture, contrasting with the active poses of the little figures, expresses his seniority and dignity. The Polynesians consider these qualities to be those of a superior social position. Despite the attention given to religious symbols, Pacific art reveals a concern with social rank.

A bis pole (right)
A memorial pole of the Asmat people
of southwestern New Guinea.
Melanesia, date unknown.
Wood. About 3.96 m high.

Tangaroa (below)
Supreme god of Polynesia.
Rurutu, Austral Islands.
Polynesia, A.D. 1700's or
early 1800's. Wood.
1.14 m high.

Drum decorated with
mask and hornbill
A dance drum from the Sepik
River region of New Guinea.
Melanesia, early A.D. 1900's.
Wood with skin and string.
60 cm high.

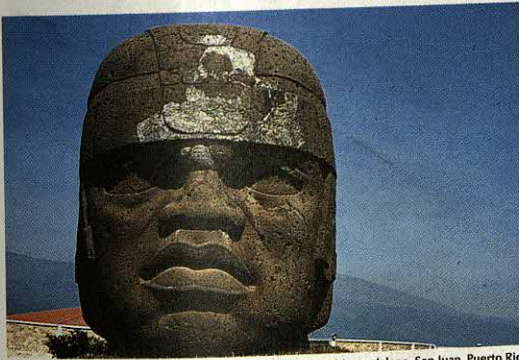
Menil Collection, Houston,
Texas, U.S.A.
Maori post figure
New Zealand,
Wood. 36.8 cm high.



Indian sculpture of the Americas

Early sculpture. The oldest well-defined sculptural traditions known thus far are those of the Olmec in Mexico and the Chavin in Peru. Both cultures developed in the centuries before 1000 B.C.

Olmec artists produced human figures in ceramic and jade. Many of these works show the distinctive features of the jaguar, an animal that often appears in Mexican and Central American art. The Olmec also made a variety of architectural sculpture, such as reliefs on buildings that show human and religious subjects. They also carved many of the large pillars called *stelae*. Perhaps the most spectacular Olmec works were colossal stone heads, which historians assume had religious significance. See also the picture of the Olmec jade head in the introduction to **Indian, American**.



Museo Jalapa, San Juan, Puerto Rico

Olmec head

800 B.C.-A.D. 600. Stone. Over 2.7 m high.

Chavin art, though smaller in scale than Olmec works, shows a similar high level of technical accomplishment. A Chavin *Bowl in the form of a jaguar* (this page) is an example. In addition to works in stone, ceramics, and shell, Chavin artists also sculpted in gold.

At the time the Olmec and Chavin were creating their first art, Indians in the southern Mississippi Valley and eastward, produced small stone sculptures called *bannerstones* and *birdstones*. The stones may have been weights for an *atlatl*, a device that permits a spear to be thrown a greater distance. They were probably made to display the prestige of their owner, to be exchanged, and to honour the dead.



University Museum, Philadelphia, U.S.A.

Bowl in the form of a jaguar

Peru (Chavin style), about 1200-400 B.C. Stone. 17 cm high.



Detroit Institute of Arts, Detroit, Michigan, U.S.A.

Metate maize-grinding platform

A.D. 1-500. Stone. 46 cm high.

Mature Indian sculpture. Although Native Americans seem to have made small-scale sculpture in clay continuously throughout much of Central and South America, more ambitious traditions developed with the rise of cities. The Maya succeeded the Olmec in southern Mexico and Guatemala. The Maya continued the production of large-scale stone architectural sculpture. They also made smaller items in jade, stone, and ceramics. See *Maya* (pictures).

In Costa Rica and Nicaragua, artists produced sculptures in ceramics, cast and hammered gold, jade, and stone. Indians throughout Central and South America made and used simple stone *metates*, stone sculptures used as maize-grinding platforms. Many elaborate ancient versions show no sign of wear (this page). They may have served as symbols of authority.

In Peru, spherical ceramic pots often were made in human or animal form. Most were for use as *grave goods*, items buried with a dead person. Some of the more complex examples were formed in clay moulds. The Moche portrait jars from the northern coastal area, depict detailed faces or crouching figures.

On the west coast of Mexico from about 300 B.C. to A.D. 200, sculptors produced many pottery grave goods. The sculptures portray people, animals, and vegetables. Increasing trade and contact throughout the Americas helped the development of urban centres in south and southeastern North America. These areas did not produce the ambitious architectural sculpture of the southern regions. However, artists did work on a smaller scale in wood, stone, clay, and metal.

The European impact. The arrival of Europeans at the end of the 1400's brought catastrophic change to the original inhabitants of the Americas. Many Indians died from diseases the Europeans introduced. In Central and South America, earlier forms of social organization were replaced by Spanish colonial rule and especially by the influence of the Roman Catholic Church. The Europeans suppressed or destroyed many local artistic and religious traditions, but others evolved into festivals based on the Christian church calendar.

In what is now the United States, Indian religious



South Dakota State Historical Society, Pierre, U.S.A.

Dance stick

Lakota effigy in the form of a horse. United States, 1884-1910. Painted wood with leather ears and reins. 94.6 cm long.

traditions survived best among remote or culturally closely knit peoples such as the Pueblo Indians. The Spaniards tried to coexist with the Indians of the Southwest. But colonists from northern Europe constantly forced the northeastern Indians westward, with little regard for their survival.

In the centre of North America, the Plains Indians' nomadic way of life made only small sculptures practical. Most Plains sculpture was created in wood, such as the *Dance stick* in the form of a horse used in ceremonial dances (this page).

The Indians of the Northwest Coast of North America made most elaborate sculpture, including carved spoons and enormous totem poles to enhance their prestige (see *Totem*).

For a detailed description of Indian sculpture, see *Indian, American*.

Greek sculpture

Early Greek sculptors made simple, formal works. They gradually learned to make realistic figures and to indicate emotion by facial expression or bodily pose. This was the style copied by Roman sculptors and re-learned by Renaissance sculptors. It served as the basic style for European sculpture until the late 1800's.

There were three major periods in the development of Greek art: (1) The Archaic period dated from about 630 to about 480 B.C. (2) The Classical period lasted until about 323 B.C. (3) The Hellenistic period ended about 146 B.C.

Archaic sculpture. In the 700's B.C., before the Archaic period, artists knew how to make only small figures of clay or bronze. However, they also may have carved wooden statues. During the 600's B.C., they began making clay figures in moulds. The Greeks learned this technique from the Phoenicians and other peoples of the East. Archaic sculptors developed a rigid and Eastern-looking style called *Daedalic*, which they also used in carving small limestone figures.

At the end of the 600's B.C., the Greeks learned from the Egyptians how to make larger statues and how to carve harder stone—their own white marble. From then until about 480 B.C., the Greeks perfected their carving techniques and figures gradually became more lifelike. They carved many standing figures of naked male youths. These figures, called *kouroi*, served as attendants to the temple of a god, or as memorials over tombs. Similar carvings of clothed maidens were called *korai* (this page). Livelier figures appeared in reliefs on tem-



Acropolis Museum, Athens, Greece

Kore 675

Greece (island of Chios), about 520 B.C. Marble. 76 cm high.

ples and treasures, about 525 B.C.

Classical sculpture. After Greek sculptors learned to show the human body accurately, they paid more attention to drapery. In early classical works, drapery hung straight and rather stiffly, as in the *Charioteer of Delphi* (page 191). In later works in the period, the garments hung in deeply cut folds. Finally, classical Greek sculptors showed drapery clinging to the body or blowing free from it.

Greek sculptors portrayed their gods as people in such works as the *Apollo Belvedere* (see *Apollo*). They showed people as godlike beings with idealized faces.

The high point of the classical style is generally considered to be the sculptures on the Parthenon in Athens. They were created after the mid-400's B.C. These sculptures celebrated the city's pride and the Greeks' defeat of the Persians in 480 and 479 B.C.

During the 300's B.C., sculptures of the human figure showed some emotion and vigorous action. For the first time, some sculptors showed goddesses nude. Lysippus made heavily built figures of athletes. Praxiteles specialized in a softer, flowing style in his figures of gods and goddesses. Sculptors decorated *sarcophagi* (stone coffins) with reliefs. A good example of such a relief is the *Alexander Sarcophagus* (page 207). Portrait sculpture also began during the classical period.

Hellenistic sculpture. The conquests of Alexander the Great carried Greek culture into Egypt and the lands



Archaeological Museum, Istanbul, Turkey

The Alexander Sarcophagus (detail)

Relief showing Alexander the Great hunting lions,
from a coffin made for a ruler of Sidon.

Phoenicia, about 323 B.C.

Painted marble. Frieze 58 cm high.

Statue of a seated boxer

Greece, about 100-70 B.C. Bronze. About 1.27 m high.

Terme Museum, Rome

of the East. After Alexander's death in 323 B.C., his empire was split into smaller kingdoms. In these kingdoms, the courts encouraged local schools of art. The most important were at Rhodes, Pergamum, and Alexandria. Artists blended local ideas with Greek standards of beauty. The result was a colourful art called *Hellenistic*.

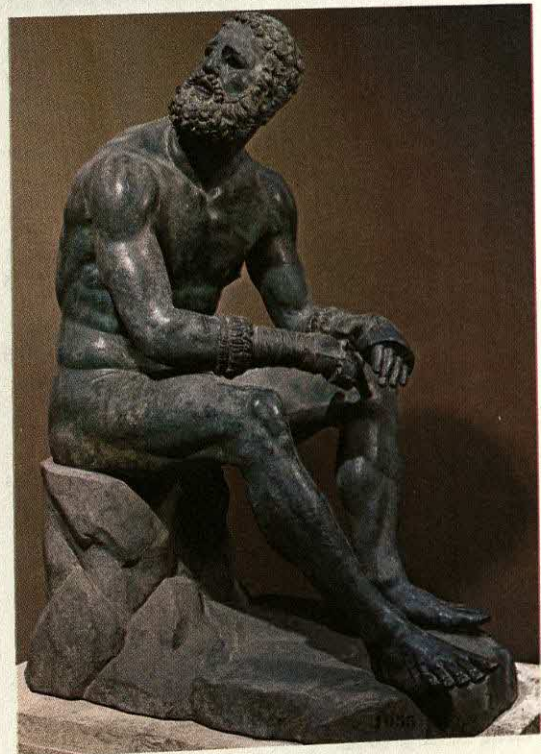
Athenian artists continued to follow a more classical style, but Hellenistic sculptors preferred to create works in active, dramatic poses. Some subjects were portrayed showing violent feelings and lifelike actions. An example appears in the *Laocoön* article. Many Hellenistic figures were much less idealistic than were earlier works. For example, in the *Statue of a seated boxer* (this page), the sculptor showed a boxer's broken nose. For more information about Greek sculpture, see *Elgin Marbles*; *Lysippus*; *Parthenon*; *Phidias*; *Praxiteles*; *Venus de Milo*.

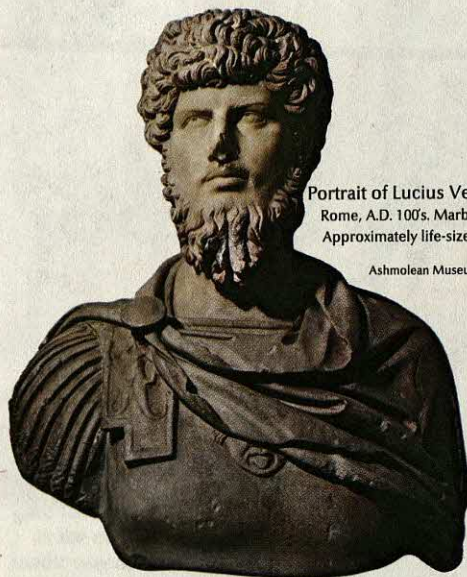
Etruscan and Roman sculpture

Etruscan sculpture. The Etruscans probably came from what is now Turkey. They migrated to Etruria (present-day Tuscany, Umbria, and Latium) in central Italy about 800 B.C. They learned sculpture from Greek artists who settled in Etruria, and from Greeks living in neighbouring colonies in southern Italy and Sicily.

The Etruscans specialized in bronzes and in terracotta works, which they painted in bright colours. An example of a bronze Etruscan statuette from the mid-400's B.C. is shown in the *Etruscans* article. Some of the best examples of Etruscan terracotta sculptures are four life-sized statues, including one of the god Apollo. These statues stood on the roof of a temple at the ancient Etruscan city of Veii, northwest of Rome. Sculptors seldom achieve figures of this size in clay, even today.

Etruscan sculptors also carved works from a soft, porous limestone called *tufa*. These works included statues found in tombs and reliefs that decorated boxes containing the ashes of the dead. The Etruscans showed a fondness for gruesome figures and portraits of ancestors. However, Etruscan artists gradually adopted classical Greek styles in sculpture.





Portrait of Lucius Verus
Rome, A.D. 100's. Marble.
Approximately life-sized.

Ashmolean Museum, Oxford

Roman sculpture. The earliest Roman sculpture was influenced by the Etruscans to the north of Rome and by Greek colonists to the south. After the Romans conquered Greece and the Hellenistic kingdoms during the 140's B.C., they brought hundreds of Greek statues to Italy. Many Greek artists worked for Roman patrons.

Greek artists brought to Italy the fully developed Hellenistic style, especially that of Alexandria. From 100 B.C. to A.D. 100, artists produced many works in a Greek style that at the same time expressed Roman ideas.

Portraiture was important in Roman sculpture. A typical portrait is the *Portrait of Lucius Verus* (this page), a Roman emperor from A.D. 161 to 169. Such portraits were more realistic than the Greek examples because Greek sculptors still idealized facial features to some degree. Compare the idealized Greek head in the *Aristophanes* article with the realistic Roman portrait in the *Cicero*, *Marcus Tullius* article. Roman sculptors often combined a Roman portrait head with a copy of a Greek statue of a god. They copied and changed famous Greek statues freely. See *Augustus*; *Caesar*; *Julius*.

The Romans created many richly carved altars. Most altar reliefs showed ceremonies or symbolic stories. The *Altar of Peace* in Rome celebrated the peace brought to the empire by Emperor Augustus.

The Romans were also particularly interested in showing historical events, a theme that the Greeks had avoided. Reliefs on commemorative arches and columns tell the story of military campaigns. The best-known columns are *Trajan's Column* (page 189) and the column of *Marcus Aurelius*, both of which show the Romans battling foreign peoples.

Relief decoration on coffins was more Greek than Roman in style and subject matter. Many reliefs symbolized Roman and Christian ideas about death.

Representative Roman sculptures are shown in *Clothing* (The Romans); *Drama* (Roman drama); *Europe* (History); *Faun*; *Mythology* (Roman mythology); *Rome, Ancient*; *Slavery*; *Toga*.

Medieval sculpture

Medieval sculpture had no definite beginning date. It emerged from the tradition of ancient Greek and Roman sculpture that gradually had become fragmented and technically inferior after the A.D. 200's. Medieval sculpture developed into an artistic tradition in its own right about A.D. 800, under the patronage of Charlemagne.

Charlemagne conquered most of what is now France, Germany, and Italy. He encouraged education for the aristocracy and founded a permanent capital at Aachen, Germany. He established centres of learning and art in royal monasteries and in his imperial court.

Early medieval sculpture. *Carolingian* art, named after Charlemagne's family, extended from the late 700's to the 800's. Workshops attached to monasteries produced most surviving sculpture of this time. Artistic production was largely religious, and chiefly applied to objects used in Christian worship. Carolingian artists created sculpture for covers of Bibles, as decoration for church altars, and for crucifixes and giant candlesticks placed on altars. Lacking other models, sculptors imitated miniatures painted on religious manuscripts.

Most Carolingian sculptures were reliefs. Some told stories, while others promoted ideas. Storytelling scenes were represented in a generally realistic style. The gold and silver *Altar frontal* (this page) was made about 835 for the Church of Sant' Ambrogio in Milan, in what is now Italy. The relief portrays an early event in the career of Saint Ambrose, his appointment as consul-general of Milan. The figures interact with each other in a believable manner within the shallow space of an abbreviated landscape.

A contrasting style of images is represented by the *Aachen situla* (page 209), made about 1000. This jewelled ivory bucket was meant to hold holy water that was sprinkled by a bishop in solemn processions. The



Altar frontal by Volvinius

Detail from a relief sculpture in the Church of Sant' Ambrogio, Milan, Italy, about 835. Gold and silver.

artist endowed the rows of rulers, saints, and guardians with a timeless sacred quality by presenting them unrealistically in a static frontal pose. At the same time, the precious materials of the bucket certified the spiritually cleansing value of the water.

The purpose of the Aachen situla typified the spread of liturgical items that developed with the elaboration of the worship service beginning in the late 800's. The expansion of the liturgy led to the creation of many objects, such as bishops' *crozier*s (staves), vessels called *pyxes* to hold Communion wafers, and containers called *reliquaries* to hold the body parts of saints.

The 1000's. The use of relief to decorate small religious objects continued throughout the Middle Ages, but after 1000 sculptors also began to produce larger-scale church furnishings. For example, artists used cast bronze to make monumental doors, candelabra, baptismal fonts, and tomb slabs. By 1100, sculptors also began to make marble furnishings, recalling the grandeur of ancient Rome. They extended the tradition of working in precious metals to stone carving, with figures sometimes cut virtually in the round. Other marble furnishings with relief images include pulpits, choir railings, shrines, and table altars.

During the 1000's, architectural sculpture began a renewal. In the next 100 years, it became the principal area of medieval sculptural achievement. The *capital* (top of a



Flight into Egypt

Capital from a column in the Church of St-Benoît-sur-Loire, France, 1000's. Stone.

column) from the church of St-Benoît-sur-Loire in France has been dated as early as the 1020's (this page). It may be one of the earliest medieval examples of figurative stone sculpture conceived in high relief. The sculpture represents the flight into Egypt of Joseph, the Virgin Mary, and the infant Jesus. The carving is skilful, but the figures are crudely portrayed. The work was carved by a mason from an architectural workshop instead of a monk from a monastery studio. The work thus marked the appearance of sculpture as a new artistic profession for *artisans* (craftworkers) outside monasteries.

The peak of architectural sculpture. Sculptors continued to devote most of their work to church decoration during the period when the great Gothic cathedrals were being built, from about 1150 to about 1300. The earliest Gothic sculpture appeared in Chartres, Paris, and other cities of northern France. Sculptors created formal, stylized works in which the vertical lines of drapery seemed to serve as additional pillars for the new, soaring Gothic architecture. An example is the detail from the *West portals of Chartres Cathedral* on page 187. The faces of the figures look more natural and human than in Romanesque sculpture.

The *Visitation group* (page 210) on the west-central portal of the Cathedral of Notre Dame in Reims, France, was carved 100 years after the Chartres portal. The sculptor portrayed the Virgin Mary and Saint Elizabeth. This work represents a completely different approach to sculptured imagery from the Chartres portal. The figures are larger than life-sized and lifelike in appearance in spite of the exaggerated rendering of the folds of the garments. The sculptor created them with believable proportions and anatomy, and used different textures for the hair, skin, and fabric.

The different styles of the two portals represent a fundamental change in the nature and function of images. The frank artificiality of Chartres contrasts with the life-like illusion of Reims. But both conceptions were prompted by the conviction that images could promote spirituality by vividly repeating sacred truths.



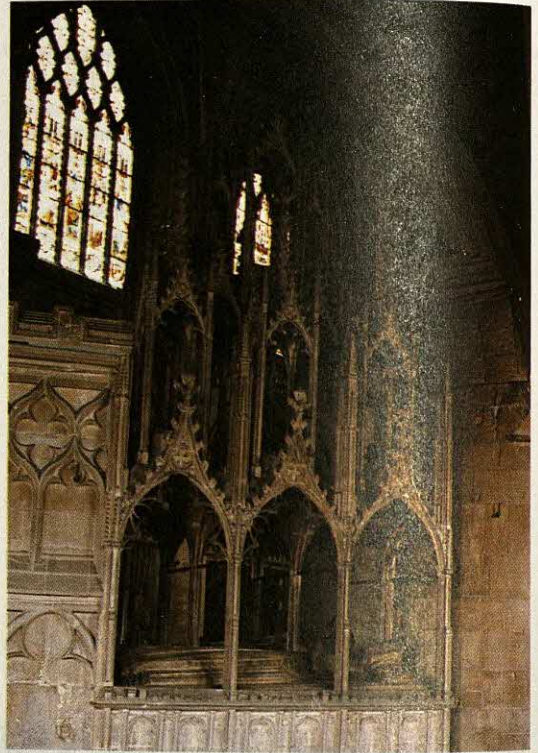
Aachen situla

Holy water vessel from Aachen Cathedral, Germany, 1000.
Ivory and jewels. 18 cm high.

Later medieval sculpture. Patrons and sculptors of the 1300's and 1400's turned sharply away from the preoccupations of their predecessors. In the 1100's and 1200's, sculptured portals had displayed in public a visual interpretation of religious truths. Late medieval sculpture primarily reflected or stimulated the religious devotion of the individual.

Monumental tombs became a major sculptural form. These tombs featured a life-sized *effigy* (image) of the deceased intended to praise his or her virtue. Tombs were as much miniature architecture as sculpture. A typical tomb was covered by a richly decorated canopy or set into a splendidly framed wall niche. The *Tomb of Hugh le Despenser*, Earl of Gloucester, was created about 1340 for Tewkesbury Abbey in England (this page). The figure on the tomb shows the dead nobleman as a Christian knight, lying with his hands folded in prayer. Originally, statues of saints were also set into little niches, testifying to the earl's holiness.

The chief artistic concern in late medieval sculpture was the free-standing devotional statue. These statues were not displayed on main altars but stood to the side or at the entrance of a lesser chapel. There the statue served as the focus for private prayers and the burning of devotional candles. For more than 200 years, no theme could rival that of the Virgin Mary in popularity. She was usually represented standing and holding the



Tomb of Hugh le Despenser
Tewkesbury Abbey, England, about 1340. Stone.

infant Jesus. Worshippers asked Mary to forward their prayers to heaven and to plead with God for help.

Artists variously imagined Mary as a simple maiden, a noble lady, or the Queen of Heaven. Late medieval statues of Mary, sometimes called *beautiful Madonna statues*, related unblemished beauty to exalted virtue. The statues were intended to reassure the worshipper of the Virgin's unfailing willingness to help those who called on her. For an example, see *Stoss, Veit* (picture: *Madonna and Child*).

See also *Architecture* (Gothic architecture); *Carolingian art*; *Cathedral*; *Gothic art*; *Milan Cathedral*; *Notre Dame, Cathedral of*; *Romanesque architecture*.

Italian Renaissance sculpture

Figures made by medieval sculptors of northern Europe represented types rather than individuals, such as the concept of a "good man." But Italian Renaissance sculptors portrayed individual people—for example, a particular man or woman who was good.

Renaissance sculpture reflected the new outlook on life that first appeared in Italy during the early 1300's. This outlook, which later scholars termed *humanism*, emphasized the importance of human beings and their activities. Humanism had its roots in the civilizations of ancient Greece and Rome. The Renaissance was given its name, which means *rebirth*, because of the revival of interest in classical art, architecture, and civilization. Artists and scholars, especially in Italy, wanted to recapture the spirit of the Greek and Roman cultures in their own

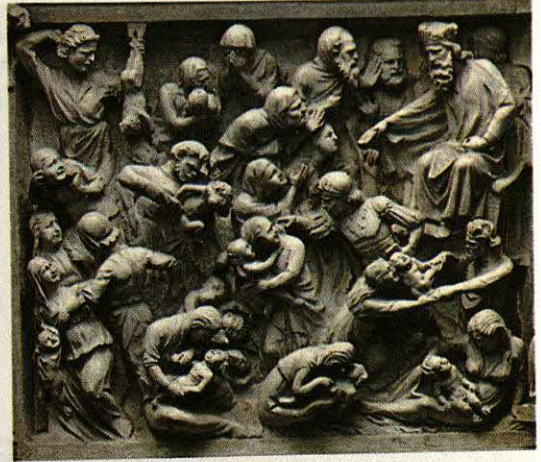


Visitation group
Figures from Cathedral of Notre Dame, Reims, France, 1220's. Stone.

art, literature, and philosophy. For more information about this rebirth of interest in classical culture, see **Humanism; Renaissance**.

In the late 1200's, Nicola Pisano and his son Giovanni began the revolutionary changes that led up to the Renaissance in Italian sculpture. They were architects and designers as well as sculptors, and are noted for their reliefs and ornamentation on pulpits. *The Massacre of the Innocents* (this page) by Giovanni Pisano is an example. The dense composition of this relief shows that the sculptor was inspired by the carved Roman coffins called sarcophagi. Its content, in which each person reacts as an individual, shows the new attitude of the Renaissance. The actual carving remains in the medieval Gothic style, however. For an earlier work by Nicola Pisano, the pulpit for the Baptistry of Pisa, see the **Relief** article.

During the 1300's, political and economic troubles in Italy limited sculptural activity. But the great revival of art in Florence about 1400 brought two generations of sculptors who were the equals of any artists anywhere at any time. They returned to classical Mediterranean



The Massacre of the Innocents by Giovanni Pisano
Detail from a panel of the pulpit in the Church of Sant' Andrea.
Pistoia, Italy, 1298-1301. Marble. 84 cm high.

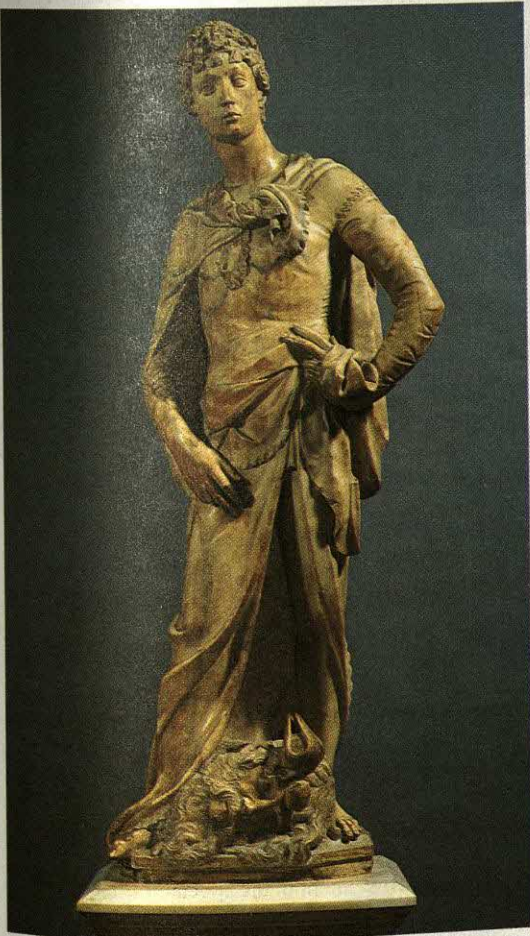
traditions and turned away from the Gothic style, which was more at home in northern Europe.

Early Renaissance. The greatest sculptor of the early Renaissance was Donatello. By 1409, he had produced a stone statue of *David* (this page) which, though Biblical in subject matter, was entirely new in spirit—the portrait of a proud, triumphant boy. In another statue of *David*, a bronze completed about 1430, Donatello revived the use of the nude figure. This statue reestablished the classical idea of beauty—the naked human body. The statue is shown in the **Renaissance** article. For other works by Donatello, see **Donatello and Dragon**.

The new naturalness quickly affected sculpture throughout Italy. Donatello decorated the pulpits and singing galleries of churches in Florence and Padua with merry *putti* (singing and dancing children). Luca della Robbia made popular coloured terracotta figures that were copied for generations. Sculptors also began to make figures of the Virgin Mary whose models might have been attractive local Italian women. These sculptures differed greatly from the formal, impersonal Romanesque and Gothic types. For an example of della Robbia's terracotta sculptures, see **Della Robbia, Luca**. See also **Terracotta**.

Other new forms of sculpture developed during the 1400's, including lifelike portrait busts and great monuments in the classical style. Desiderio da Settignano became famous for portraits. Among the other brilliant sculptors of the 1400's were Jacopo della Quercia, Michelozzo Michelozzi, Bernardo and Antonio Rossellino, and Agostino di Duccio.

In the mid-1400's, Donatello moved to Padua. His style of modelling became more precise and sharp, and influenced the whole trend of sculpture in northern Italy. Among the sculptors influenced by this new style were the Mantegazza brothers, Giovanni Amadeo, the Lombardi family, and the great bronze worker Andrea Briosco, who was called *Il Riccio*. They all showed rather stylized, flattened planes in their works. Only in later nonreligious works, such as small bronzes and medals, did sculptors return to rounder, classical forms.



Museo Nazionale del Bargello, Florence, Italy

David by Donatello
Italy, about 1408. Marble. Figure about 1.57 m high.



Piazza della Signoria, Florence, Italy

Statue of Perseus by Benvenuto Cellini
Italy, 1545-1554. Bronze. Figure 3.20 m high.



Medici Chapel, Florence, Italy

Tomb of Lorenzo de' Medici by Michelangelo
Italy, about 1524-1534. Marble. Figures life-sized.

Two important sculptors of the late 1400's were Antonio del Pollaiuolo and Andrea del Verrocchio, both of Florence. Pollaiuolo, like Donatello and many other artists of this period, made a careful study of the appearance of muscles while the body is in motion. These artists caught fleeting moments of tense action in their poses. Verrocchio designed the powerful realistic portrait of the Renaissance political and cultural leader Lorenzo de' Medici. This portrait is shown in the **Renaissance** article.

Michelangelo. The great flood of Italian genius reached its peak in the early 1500's in Michelangelo Buonarroti. His great brooding sculptures, including the figures of *Evening* and *Dawn* on the *Tomb of Lorenzo de' Medici* (this page) in Florence, carry the observer beyond earthly reality. The deep feeling and emotion of his figures set them apart from all other sculpture of that time. For additional examples of Michelangelo's sculpture, see **Italy (Arts)** and **Michelangelo**.

Most other sculptors of the 1500's produced rather forced adaptations of imperial Roman figures and groups. Some monumental dignity can be seen in the works of such Venetian sculptors as Jacopo Sansovino and Alessandro Vittoria. Other sculptors followed Giambologna's experiments in composition in which figures turn and twist in complicated poses. Still others, including Benvenuto Cellini and Bartolommeo Ammannati, de-

veloped the *mannerist* style (see **Mannerism**). This style emphasized grace and elegance, and resulted in the creation of slender, artificial figures. An example is Cellini's bronze *Statue of Perseus* (this page). Cellini's famous saltcellar for King Francis I of France is shown in the article **Cellini, Benvenuto**. For more information on Italian Renaissance sculpture, see **Florence (picture)**; **Ghiberti, Lorenzo**; **Pisano, Giovanni**; **Pisano, Nicola**.

Sculpture from 1600 to 1900

European sculpture. The greatest master of European sculpture in the 1600's was Gian Lorenzo Bernini of Italy. Bernini was a superlative craftsman and also an outstanding architect. His sculpture for the *Tomb of Pope Alexander VII* (page 213) is typical of the *baroque* style of the period because it was designed to appeal primarily to the emotions and senses. Bernini combined emotional and sensual freedom with theatrical presentation and an almost photographic naturalism. Bernini's saints and other figures seem to sit, stand, and move as living people—and the viewer becomes part of the scene. This involvement of the spectator is a basic characteristic of baroque sculpture. See **Altar**.

The sculptors who succeeded Bernini in Rome during the late 1600's softened the dynamic and showy baroque style. They used a more static and restrained classical style. These artists were technically skilled and

made hundreds of monuments that filled the churches of the time. By the early 1700's, they had become more interested in technical skill than in content, and their art reflected the change. But these artists had an important influence on sculptors of France and Flanders who made up the Franco-Flemish school.

Franco-Flemish sculptors were responsible for many church and public monuments built in northern Europe during the 1700's. Their sculptures decorated many royal palaces and gardens, including Versailles in France. These artists all followed the same style. They combined naturalistic details with artificial poses and gestures, as shown in Antoine Coysevox's statue of *Mercury* (this page).

A brilliant new movement called *rococo* grew up in Germany during the early 1700's. The movement was led by such artists as Ignaz Gunther and Ferdinand Dietz, whose works are dramatic, colourful, and technically superb. Rococo saints and goddesses mingle in architecture with plasterwork and painted ceilings to create an extraordinary world of fantasy.

The *neoclassical* movement arose in the late 1700's. The members of this vast international school restored what they regarded as classical principles of art. They were direct imitators of ancient Greek sculptors. They emphasized classical drapery and the nude. Leading neoclassical sculptors included Antonio Canova of Italy, John Flaxman of England, and Bertel Thorvaldsen of Denmark. Thorvaldsen's delightful marble statue *A Shepherd Boy* (this page) is typical of the neoclassical style. This style greatly influenced churchyard and public monuments.



St. Peter's Basilica, Rome

Tomb of Pope Alexander VII by Gian Lorenzo Bernini

Italy, 1671-1678. Marble and gilt bronze. Figures larger than life-sized.



Thorvaldsens Museum, Copenhagen, Denmark

A Shepherd Boy by Bertel Thorvaldsen
Denmark, 1817-1825. Marble. 1.45 m high.



Gardens of the Tuilleries, Paris

Mercury by Antoine Coysevox
France, 1700-1702. Marble. About 3.05 m high.

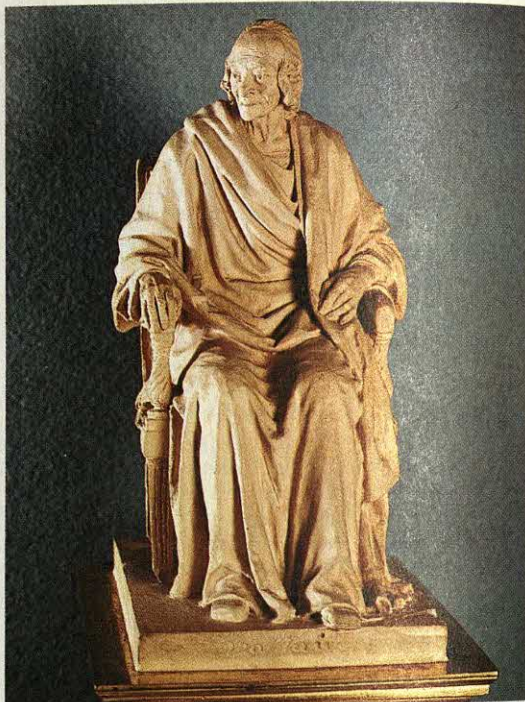
Jean Antoine Houdon of France was perhaps the greatest European sculptor of the 1700's. He was known chiefly for his portraits of important men and women in Europe and America. These portraits show Houdon's ability to capture the personalities of his subjects and his genius at working in a wide variety of materials. The marble statue of the French philosopher *Voltaire* (this page) is one of his best-known works.

The *romantic* movement began in the 1830's and existed side by side with neoclassicism until about 1900. Romantic sculpture was sentimental, and it appealed to the senses. Leading sculptors who worked in the romantic style included François Rude, Jean Baptiste Carpeaux, and Auguste Rodin, all of France. Such works as Rodin's *Orpheus* (this page) emphasize the possibilities of the modeller's technique. Rodin's technique greatly influenced sculpture of the 1900's. For additional examples of European sculpture of this period, see *Adonis*; *Canova, Antonio*; *France (Arts)*; *Rodin, Auguste*.

American sculpture. North America had no professional sculptors until the late 1700's. However, anonymous craftworkers created fine examples of what is called *folk art*. The *Gravestone* by Zerubbabel Collins and other gravestones in New England cemeteries reflect Puritan ideals in crude but fanciful reliefs. Many metal weather vanes featured fanciful designs.

Orpheus by Auguste Rodin
France, 1892. Bronze. 1.50 m high.

Musée Rodin, Paris



Musée Lambinet, Versailles, France

Voltaire by Jean Antoine Houdon
1781. Marble. Life-sized.

In the 1820's, American sculptors started to go to Italy, where they were greatly influenced by the classical works they saw. Congress commissioned Horatio Greenough to make a colossal marble *Statue of George Washington* (page 215). Greenough represented his subject seated, seminude, in the pose of the Greek god Zeus. Hiram Powers created smooth and impersonal nude mythological figures, and some remarkable realistic portrait busts of public men. William Rimmer made a few dramatic, struggling figures. These figures were more emotional, powerful, and tragic than earlier American works. They showed a great knowledge of anatomy and a strong feeling of tension. John Rogers made small groups of Civil War scenes. Rogers also created works that suggested the pleasant, warm-hearted quality of small-town everyday life.

About the mid-1800's, French influence began to be felt more strongly than Italian. The greatest American sculptor of his period was Augustus Saint-Gaudens, best known for his statues of Abraham Lincoln.

Important sculptors of the late 1800's included Daniel Chester French, who made many serene and idealistic compositions, and George Grey Barnard, master of the expressive human figure. Frederick MacMonnies introduced extravagant and rich surface details into the monumental style. Frederic Remington showed another aspect of American life in his small bronzes. He used vivid, dramatic themes from the life of the Far West in such works as *The Cheyenne* (page 215). For additional examples of American sculpture of this period, see *Remington, Frederic*; *Saint-Gaudens, Augustus*.

Modern international sculpture

Sculpture of the 1900's has become increasingly international in character as national differences in the art form have disappeared. New ways of thinking about sculpture have resulted in exciting and original developments. The human figure, for many years the favourite subject of sculptors, has become less important. Instead, many sculptors have become more and more involved in problems of pure form, avoiding recognizable content. Artists also frequently use the shapes of modern machines in their works. Many new materials, such as plastics and aluminium, have made a strong impact on the look of sculpture in the 1900's.

Cubism and futurism. Many new artistic ideas appeared during the years just before World War I began in 1914. *Cubism* and *futurism* were two related movements that led to experiments in both sculpture and painting. Cubist sculptors, including the Spanish-born Pablo Picasso and the Lithuanian-born Jacques Lipchitz, represented objects in such basic geometrical forms as cubes, cylinders, and cones. They were also among the first to experiment with hanging sculptures on walls in the manner of paintings. An example is Picasso's sheet metal and wire *Guitar* (this page).

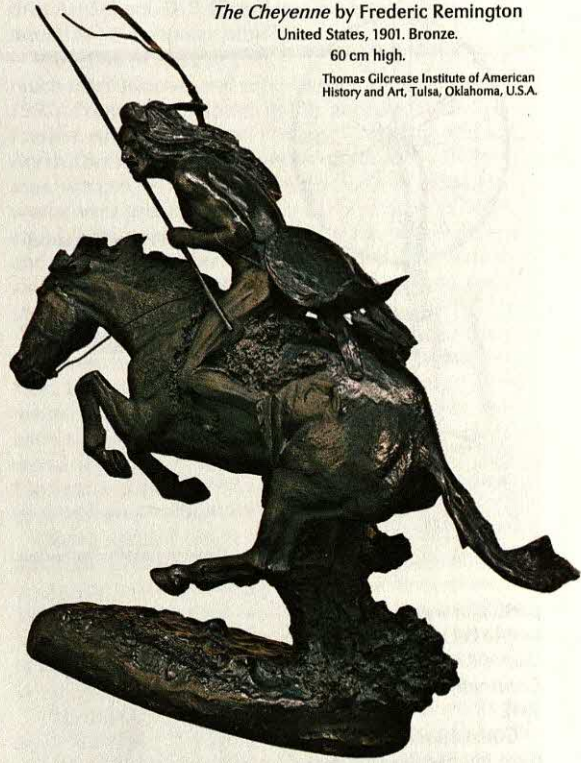
Futurist sculptors tried to show how space, movement, and time affected form. These artists portrayed objects in motion, rather than their appearance at any

The Cheyenne by Frederic Remington

United States, 1901. Bronze.

60 cm high.

Thomas Gilcrease Institute of American History and Art, Tulsa, Oklahoma, U.S.A.



The Smithsonian Institution, Washington, D.C.

Statue of George Washington by Horatio Greenough

United States, 1840. Marble. 3.45 m high.



The Museum of Modern Art, New York City

Guitar by Pablo Picasso

France, 1912-1913. Construction of sheet metal and wire. 77.5 cm high.



Bicycle Wheel by Marcel Duchamp

1951, third version after lost original of 1913. Metal wheel 64.8 cm in diameter mounted on a painted wood stool.

The Museum of Modern Art, New York City

particular moment. An example is Umberto Boccioni's *Unique Forms of Continuity in Space* (page 191).

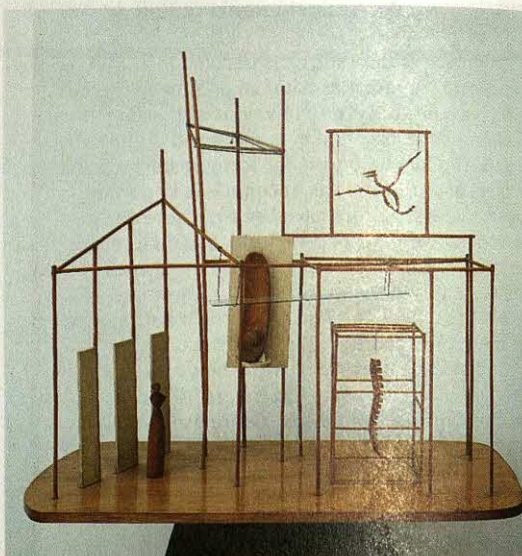
Constantin Brancusi gave intense life and character to severely controlled and limited forms. Brancusi's famous bronze *Bird in Space* (this page) abstractly suggests soaring movement without attempting to physically portray a bird. See Brancusi, Constantin.

Assemblages. During the early 1900's, two revolutionary art movements called *dadaism* and *surrealism* made significant new contributions to sculpture. Dada artists such as Marcel Duchamp of France explored the use of discarded materials not previously accepted by artists. Dadaists created works out of abandoned machine parts, pieces of wood, household items, and similar articles, called *found objects*. These artists often pieced elements together to create a type of sculpture now called *assemblages* or *constructions*. An early example is Duchamp's *Bicycle Wheel* (this page). Some sculptors, such as Alberto Giacometti



Bird in Space by Constantin Brancusi

1940. Polished bronze. 1.32 m high.



The Museum of Modern Art, New York City

The Palace at 4 A.M. by Alberto Giacometti

1932-1933. Wood, glass, wire, and string. 71.8 cm high.

of Switzerland, captured the favourite surrealist subject matter of dreams, nightmares, or fantasies. Giacometti's *The Palace at 4 A.M.* (this page) is an example. See Dadaism.

Figurative form. Not all sculptors of the early and middle 1900's abandoned figurative sculpture. Certain artists developed new and original ways of handling figurative forms. Henry Moore of England made vast wood or stone figures such as *Reclining Figure* (this page). Although the human figure is clearly recognizable, it has been reduced to an abstract form that also seems part of a landscape. The *voids* (holes) in the statue allow it to interact more fully with the space around it and add a sense of mystery to the work.

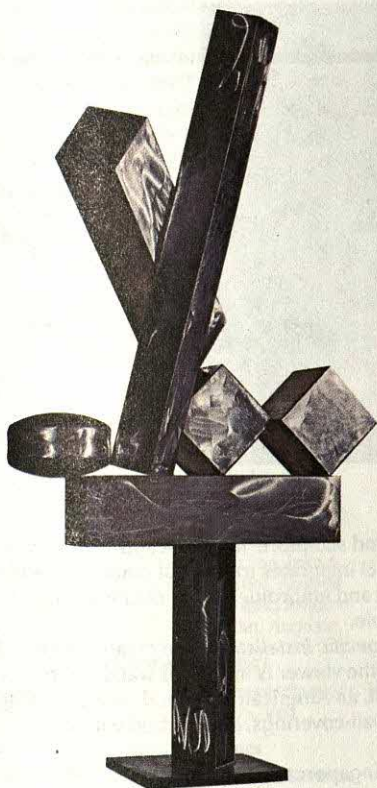
In India at this time, figurative sculpture moved away from an emphasis on the grandiose toward a portrayal of the experiences of the common man. For example, B. V. Talim's bronze sculpture *Poverty* (1930), is of a poor man mending clothes. Other notable sculptors of the period include V. P. Karmakar, R. P. Kamat, N. G. Pansare,



Albright-Knox Art Gallery, Buffalo, New York, U.S.A.

Reclining Figure by Henry Moore

1936. Elmwood. 89 cm long.



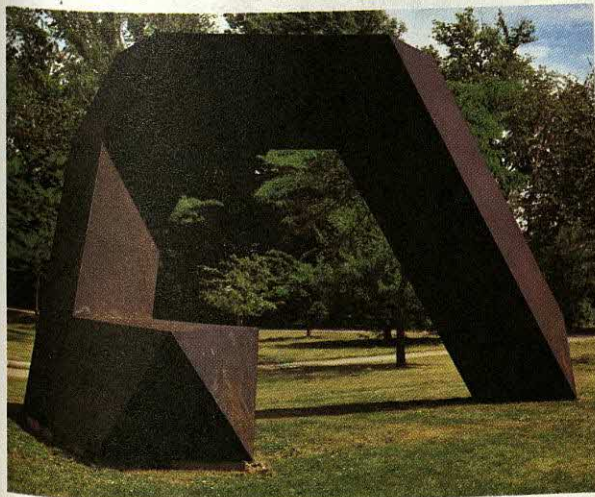
The Tate Gallery, London

Cubi XIX by David Smith
1964. Stainless steel. 2.87 m high.

and Roy Choudery. Many monumental bronzes of the 1940's and 1950's reflected socialist concerns as in *Triumph of Labour* (1954) by the Bengali principal of Ma-

Cigarette by Tony Smith
1967. Steel. 4.6 m high.

Albright-Knox Art Gallery, Buffalo, New York, U.S.A.



dras Art School, D. P. Choudery. The female figure continued to be a popular subject.

Varieties of abstraction. Indian sculpture became much more abstract and experimental after the late 1950's. Prominent sculptors of this period include S. L. Prasher, Armanath Sehgal, Premoja Choudury, and K. C. Aryan. Dhanraj Bhagat, a major sculptor in the Delhi area, worked in wood, cement, plaster, and metal. His works were portable and many of them, such as *Monarch* (1968), were embellished with nails, wooden pegs, and metal pieces. Many artists combined natural materials with synthetic products such as glass, plastic, and styrofoam.

The American sculptor David Smith played a major role in exploring the sculptural possibilities of stainless steel. Using abstract geometric forms, he created monumental works that dramatically experimented with balance, space, and surface treatment. Many of his welded works seem to defy gravity, such as *Cubi XIX* (this page). Even more abstract are the simplified representations of organic forms by the French artist Jean Arp.

During the mid-1900's, nonfigurative sculpture dominated the work of many artists. Some sculptors created works that seem to have been produced by machines. They made sculptures in aluminium, plastics, and other industrial materials. The forms remain severely geometrical, deliberately anonymous, and almost totally impersonal. These artists became known as *minimalists*.

The American sculptor Tony Smith created works that typify the minimalist style. In *Cigarette* (this page), Smith produced a sculpture that is clear, simple, and based on elementary geometric forms and relationships. Smith deliberately avoided self-expression. *Cigarette* suggests no recognizable ideas or images. Its impact lies in the materials used and the proportional relationships of the

Woman with Suitcases
by Duane Hanson
1973. Painted fibreglass and
polyester. Life-sized figure.





Surrounded Islands by Christo made a brilliant splash of colour off the coast of Florida, U.S.A. in 1983.

parts. In many ways, Smith worked like an engineer rather than a traditional sculptor. Other leading minimalist sculptors include the Americans Carl Andre and Donald Judd.

The superrealists. During the 1960's and 1970's, some artists began practising an extreme form of realism, commonly called *superrealism*. The superrealists included the Americans John De Andrea and Duane Hanson. These artists created life-sized casts of people in everyday situations. Many of Hanson's works comment on society, while De Andrea's tend to explore the relationship between the ideal and reality.

Duane Hanson's *Woman with Suitcases* (page 217) combines the technique of casting from a living subject with fibreglass and polyester materials. The result seems alive. To make the illusion of reality more complete, Hanson added real hair, clothes, and accessories to the sculpted figure.

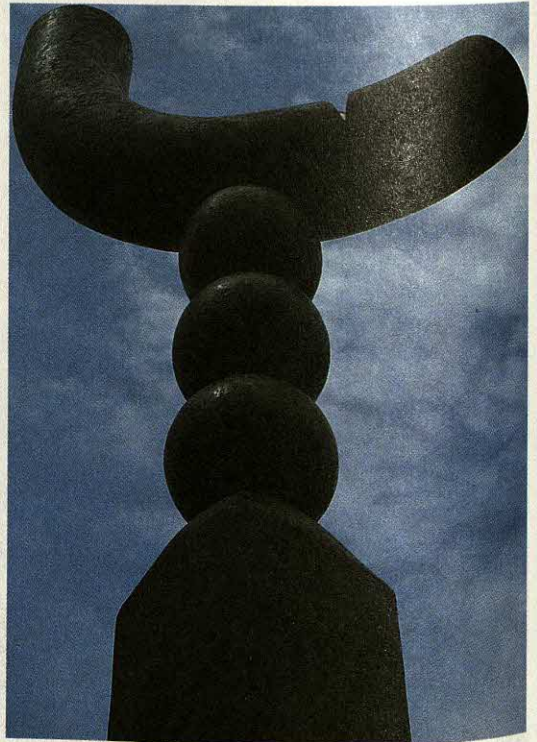
Environmental sculpture. Some sculptors have created works of art that are sculpted out of the landscape, using rocks, earth, water, and other natural materials. These works are called *environmental sculptures*, and sometimes *land art* or *earthworks*. The American artist Robert Smithson made the relatively permanent *Spiral Jetty* (1970) out of rocks in the Great Salt Lake in Utah. The Bulgarian sculptor Christo created a short term project of surrounding a group of islands off the coast of Florida in the United States with bright pink polypropylene fabric. In South Africa during the 1980's, Wendy Ross and Gerald Hagg also produced works which interacted with their natural surroundings. Ross's *Beach Piece* consisted of flat, dark squares of perspex placed at intervals on Addington Beach, Durban. *Shelter*, by Hagg, blended boulders, railway sleepers, and wooden poles into a grassy landscape.

The late 1900's has seen the distinction between sculpture and other art forms become less definite. Today, sculptors create works from shaped and painted canvas, and combinations of many materials. The American sculptor Marisol wittily combined painting and wooden sculpture with actual clothing, furniture, and other everyday objects. American Robert Arneson and others broke down the artificial division between ce-

ramics and sculpture. Judy Chicago's *The Dinner Party* (page 188) integrates traditional women's crafts such as weaving and embroidery with ceramics on a large triangular table.

Site-specific installations are created for a particular site and the viewer is invited to wander through them. Judy Pfaff, an American, included painted ceilings, neon, plastic wall-coverings, and barbed wire in her installations.

The Singaporean sculptor Ng Eng Teng trained in ce-



Balance, by Singapore sculptor Ng Eng Teng (1981), is both massive and elegant. It is 5.6 metres tall and 2.5 metres wide.

ramics. Several of his monumental public sculptures in Singapore, such as *Mother and Child* (1980), are made of *ciment fondu*, a quick-hardening refractory cement.

Malaysian-born sculptor Tan Teng Kee chose steel as his medium after studying in Dusseldorf, Germany. Examples of his work include the monumental *Endless Pillar* (1977) and *Endless Flow* (1980), both made of welded brass and stainless steel.

Related articles in *World Book*. See the *Arts* section of the various country articles, such as *Ireland* (Arts). See also:

American sculptors

Borglum, Gutzon	Oldenburg, Claes
Calder, Alexander	Powers, Hiram
Dallin, Cyrus E.	Rauschenberg, Robert
Johns, Jasper	Remington, Frederic
Lippold, Richard	Roszak, Theodore
Marisol	Russell, Charles M.
Milles, Carl W. E.	Saint-Gaudens, Augustus
Nevelson, Louise	Segal, George
Noguchi, Isamu	Taft, Lorado

French sculptors

Arp, Jean	Degas, Edgar
Bartholdi, Frédéric A.	Houdon, Jean A.
Barye, Antoine L.	Maillol, Aristide
Brancusi, Constantin	Pevsner, Antoine
Coysevox, Antoine	Rodin, Auguste

German sculptors

Barlach, Ernst H.	Riemenschneider, Tilman
Lehmbruck, Wilhelm	Stoss, Veit

Italian sculptors

Bernini, Gian Lorenzo	Ghiberti, Lorenzo
Boccioni, Umberto	Michelangelo
Canova, Antonio	Pisano, Giovanni
Cellini, Benvenuto	Pisano, Nicola
Della Robbia, Luca	Pollaiuolo, Antonio del
Donatello	Verrocchio, Andrea del

Other sculptors

Archipenko, Alexander	Lipchitz, Jacques
Chadwick, Lynn Russell	Lysippus
Charoux, Siegfried	Meštrović, Ivan
Epstein, Sir Jacob	Moore, Henry
Flaxman, John	Phidias
Frink, Dame Elizabeth	Picasso, Pablo
Gabo, Naum	Praxiteles
Giacometti, Alberto	Sekoto, Gerard
Gill, Eric	Thorvaldsen, Bertel
Hepworth, Barbara	Van Wouw, Anton

Famous sculptures

Elgin Marbles	Nefertiti
Farnese Bull	Sphinx
Laocoön	Statue of Liberty
Mount Rushmore National Memorial	Venus de Milo

History of sculpture

Assyria (Art and architecture; pictures)	Greece, Ancient (Arts)
Aztec (Arts and crafts)	Indian, American (Arts and crafts)
Babylonia (Art; picture)	Maya (Arts and crafts; pictures)
Celtic art (Sculpture)	Persia, Ancient (pictures)
Egypt, Ancient (Painting and sculpture)	Rome, Ancient (Arts and sciences)
Etruscans (Language and culture; pictures)	

Kinds of sculpture

Collage	Mask	Relief
Gargoyle	Mobile	Sarcophagus

Methods and materials

Alabaster	Lacquer
Bronze	Marble
Cast and casting	Plaster of Paris
Clay	Plastics
Ebony	Soapstone
Fibreglass	Terracotta
Iron and steel	Welding
Ivory	Woodcarving
Jade	

Styles

Baroque	Humanism
Byzantine art	Impressionism
Carolingian art	Pop art
Classicism	Renaissance
Cubism	Rococo
Futurism	Romanticism
Gothic art	

Other related articles

Africa (Arts)	Eskimo (picture)
Art and the arts	India, Art of
Architecture	Latin America (Arts)
Asia (Way of life)	Philippines, Art of the
Australian art	South Africa, Art of
Cathedral	United Kingdom, Arts of the
Design	
Easter Island	

Outline

- I. The importance of sculpture
- II. Sculpture as an art form
- III. The sculptor at work
- IV. Beginnings
- V. Asian sculpture
- VI. African sculpture
- VII. Pacific Islands sculpture
- VIII. Indian sculpture of the Americas
- IX. Greek sculpture
- X. Etruscan and Roman sculpture
- XI. Medieval sculpture
- XII. Italian Renaissance sculpture
- XIII. Sculpture from 1600 to 1900
- XIV. Modern international sculpture

Questions

Why did prehistoric peoples create sculpture?
 What is sculpture in the round?
 What is relief sculpture?
 How can sculptors create the illusion of movement?
 Why do Buddha figures emphasize swelling, rounded forms?
 What is *minimalist* sculpture?
 Where was most Carolingian art created?
 How did Donatello influence Renaissance sculpture?
 How do modern sculptors cut and shape metal?
 What was the function of the medieval devotional statue?

Sculthorpe, Peter (1929-), an Australian composer, gained international attention for his *Sun Music*, performed in London in 1965. His *Irkanda IV* for solo violin, strings, and percussion, and his *String Quartet No. 6* have been widely performed.

Peter Joshua Sculthorpe was born in Launceston, Tasmania. He studied at the Melbourne University Conservatory of Music and later at Oxford University in England. He became a teacher at Sydney University in 1963. Sculthorpe was named Officer of the Order of the British Empire in 1977.

Scunthorpe (pop. 60,500) is a modern town and local government district in Humberside, England. It lies near the River Trent. Scunthorpe, with its blast furnaces, rolling mills, and iron smelters, is a centre for steel milling.

Other industries in Scunthorpe include electronics, food processing, and the manufacture of clothing, furniture, plastics, and telecommunications goods. Many of these industries are in the Scunthorpe enterprise zone. Places of interest include Normanby Hall, which is the site of the annual Scunthorpe Horse Trials, and a farming museum.

See also **Humberside**.

Scurvy is a disease caused by lack of *ascorbic acid* (vitamin C) in the diet.

If a person does not get enough vitamin C, any wound he or she might have heals poorly. The person also bruises easily. The walls of the *capillaries* (small blood vessels) become so weak that slight pressure may cause them to break. The mouth and gums become sore. The gums bleed and the teeth may become loose. Patients lose their appetite, their joints become sore, and they become restless. Anaemia may also develop.

Scurvy has been known since ancient times. It was once a common disease among sailors. During long voyages, sailors rarely had fresh fruits and vegetables. They lived on salt beef and *hardtack* (dry biscuits) for weeks at a time. Portuguese navigator Vasco da Gama once lost about 100 out of 170 men from scurvy. In 1753, James Lind, a Scottish doctor, showed that eating oranges and lemons would cure scurvy, and that adding lemon juice to the diet would prevent the disease. In 1795, the British Navy followed his advice and began issuing daily rations of juice to its men.

Improved understanding of nutritional requirements has made scurvy rare. Foods especially rich in vitamin C include citrus fruits, tomatoes, cabbage, lettuce, celery, onions, cress, carrots, and potatoes. These foods should be fresh to be most useful in supplying vitamin C. Including such foods in the diet will prevent or cure scurvy.

See also **Vitamin** (Vitamin C).

Scylla, in Greek mythology, was at first a beautiful nymph. The Roman poet Ovid told how the sea-god Glaucus fell in love with Scylla when Glaucus saw her walking on the shore by the Strait of Messina. Scylla would not love Glaucus, and so Glaucus went for help to the sorceress Circe. Circe asked him to love her instead of Scylla, but he would not. In a rage, Circe turned Scylla into a sea monster, part woman and part fish, with heads of dogs growing out of her waist.

Scylla then lived in a cave above the Strait of Messina opposite the whirlpool Charybdis. Scylla seized and ate sailors that came too close. When Odysseus (Ulysses in Latin) passed that way, she seized six of his men (see **Odyssey**; **Ulysses**). Sailors tried to steer a middle course between Scylla and Charybdis. This expression is sometimes used when a person speaks of having to take a course between two evils.

Scythe, an implement with a curved cutting blade, was once widely used to harvest grain. It has a long, bent wood handle, called a *snath*, with a short bar for each hand, distinguishing it from the *sickle*, which has a short handle for one hand. The *cradle scythe* has fingers or light rods which receive the grain and lay it in even piles on the stubble in the field.

On average, a farm worker would cut about 0.5 hectare of grain per day with a scythe, although an expert could cut at nearly twice this rate.



A sea anemone has a cylinder-shaped body topped by many tentacles (tiny arms), which surround the animal's mouth and are used for feeding.

SDI. See **Strategic Defense Initiative**.

Sea. See **Ocean**.

Sea anemone is a sea animal that looks like a flower called the *anemone*. The shape of the animal's body and its bright colour give it a plantlike appearance. Its body may be blue, green, pink, red, or a combination of colours. The sea anemone can move slowly. But it usually remains fixed to a rock or other surface. Sea anemones are *cnidarians* (coelenterates), the group of water animals that includes corals, hydras, and jellyfish. The animal's body diameter varies from about 5 millimetres in some species to more than 90 centimetres in the giant sea anemone of Australia.

Like some other cnidarians, sea anemones are *polyps*. One end of the cylinder-shaped body attaches to rocks, shells, or wharf pilings. The other points outward. This end has a mouth surrounded by *tentacles* (tiny arms). Sea anemones capture food with their tentacles. Stinging cells in the tentacles throw out tiny poison threads that paralyse other small sea animals. The tentacles drag prey into the mouth. The mouth leads to a large cavity, where the food is digested. When a sea anemone is disturbed, it pulls in its tentacles and shortens its body. It then looks like a round lump on a rock.

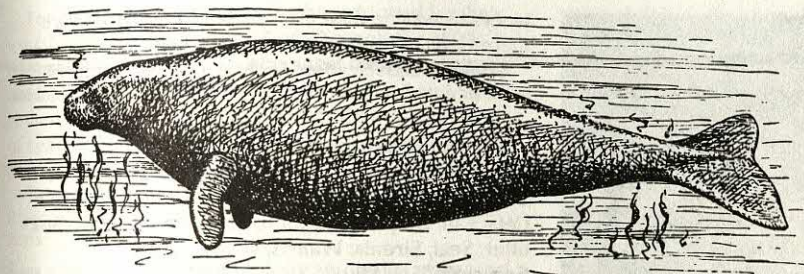
A sea anemone reproduces by forming eggs, by dividing in half, or by *budding*. When it buds, a young sea anemone grows out of the base of the parent's body. Eventually, the young sea anemone breaks off and grows by itself.

Scientific classification. Sea anemones belong to the phylum Cnidaria (Coelenterata). Sea anemones are in the class Anthozoa.

See also **Animal** (picture: Animals of the oceans); **Ocean** (picture: Benthos).

Sea animal. See **Marine biology** and its list of *Related articles*.

Sea bird. See **Bird** (Birds of the Arctic; Sea birds and birds of the Antarctic).



Steller's sea cow lived in shallow water near shore. It became extinct a few years after its discovery in 1741.

Sea cow is a term sometimes applied to the dugong and manatee, which belong to an *order* (group) of sea mammals called *Sirenia*. But the term more correctly applies to an extinct animal called *Steller's sea cow*. The Steller's sea cow was discovered in 1741 near the Commander Islands in the Bering Sea. The total population then probably numbered between 1,000 to 2,000. Sailors killed the animals for food, and by 1768 they were extinct. The Steller's sea cow lived in shallow water near shore. It fed on seaweed. It was the largest sirenian and the only one adapted to cold water. It grew about 7.6 metres long and weighed almost 10 metric tons.

See also **Dugong; Manatee; Sirenia**.

Scientific classification. The Steller's sea cow belongs to the order *Sirenia*. It is in the family *Dugongidae*. It is *Hydrodamalis gigas*.

Sea cucumber is a type of sea animal with a long fleshy body that may look like a cucumber. It belongs to a group of spiny-skinned animals called *echinoderms* (see **Echinoderm**). Other echinoderms, including sea urchins and starfish, have sharp spines on the outside of their bodies. A sea cucumber's spines, however, are buried deep in its skin. About 500 species of sea cucumbers live in the oceans of the world at all depths. Some tropical sea cucumbers grow up to 60 to 90 centimetres long. Most sea cucumbers that live in cooler regions are much smaller.

A sea cucumber's mouth is at one end of the body and is surrounded by branching tentacles. The tentacles can lengthen and shorten, catch food, and pass food into the mouth. There are five double rows of tiny tube-like structures called *tube feet* on the body. The tube

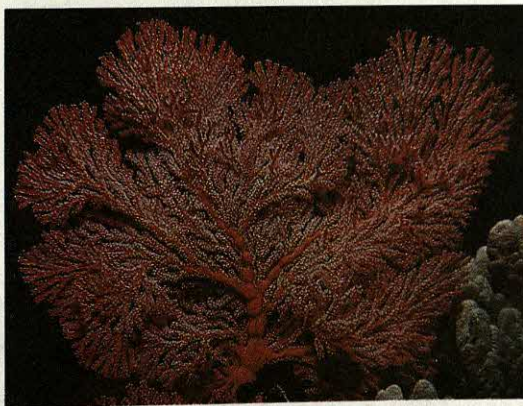
feet have suction discs on their ends that help the animal crawl or attach itself to objects.

A sea cucumber breathes by pumping water in and out of an organ called a *respiratory tree*. The animal also can throw out internal body parts to distract attackers. New body parts are later regrown. In Asia, sea cucumbers are dried and sold as food called *trepang* (see **Trepang**).

Scientific classification. Sea cucumbers belong to the phylum *Echinodermata*, class *Holothuroidea*.

Sea elephant, or elephant seal. See **Seal**.

Sea fan is a colourful coral with a flat, fanlike shape. It has a strong, flexible skeleton that branches to form a lacy network. A sea fan actually consists of a colony of individual coral animals called *polyps*. The polyps grow from the soft tissues that cover the skeleton. Sea fans are common in the reefs and shallow waters along the



A **sea fan** is a brilliantly coloured coral with a fanlike shape. Sea fans are often found in the reefs and shallow coastal waters of subtropical and tropical regions.



A **sea cucumber** is a sea animal with a cylindrical body that resembles a cucumber. Its mouth is at one end of its body.

coasts of Florida, U.S.A., and the West Indies. They are often coloured brilliant red, yellow, orange, or purple.

Scientific classification. Sea fans belong to the order *Gorgonacea* of the phylum *Cnidaria*.

Sea gooseberry. See **Ctenophore**.

Sea gull. Any gull found on or near the sea. See **Gull**.

Sea horse. See **Seahorse**.

Sea leopard, or leopard seal. See **Antarctica** (Animal life; picture).

Sea level is the level of the ocean's surface. It changes continuously with the tides, and it varies from one part of the world to another. *Mean sea level* is the average



A sea lily is a deep-sea animal.

sea level calculated from measurements made over a long period of time. Geographers use mean sea level as the starting level for measuring the height or depth of the earth's surface. For example, the highest mountain in the world, Mount Everest, in the Himalaya rises 8,848 metres *above* sea level. Death Valley, in California, is 86 metres *below* sea level.

Sea lily is a sea animal that looks like a flower. It belongs to a group of spiny-skinned animals called *echinoderms* (see *Echinoderm*). This group also includes starfish and sea urchins. Sea lilies were abundant in prehistoric times, but only a few kinds remain today.

Sea lilies live mostly in deep ocean waters. The animal attaches itself to the ocean bottom with its stalk. The main part of the body, called the *calyx*, is on top of the stalk. The mouth faces upward from the centre of the calyx. Five featherlike arms extend from the calyx into the water current. The arms have small shoots that collect food and pass it in grooves to the mouth. Sea lilies eat tiny aquatic organisms.

Closely related animals called *feather stars* resemble sea lilies in appearance. However, feather stars break from their stalks when young and live free, often on tropical coral reefs. Feather stars can swim short dis-

tances by waving their arms up and down. There are more kinds of feather stars than sea lilies.

Scientific classification. Sea lilies and feather stars belong to the phylum Echinodermata. They make up the class Crinoidea.

See also *Ocean* (picture: Benthos).

Sea lion. See *Seal*.

Sea mammal is a mammal that lives in the sea. See *Cetacean*; *Dolphin*; *Dugong*; *Manatee*; *Sea cow*; *Sea otter*; *Seal*; *Sirenia*; *Walrus*; *Whale*.

Sea mile. See *Mile*.

Sea nettle. See *Jellyfish*.

Sea of . . . See articles on seas listed under their key word, as in *Japan*, *Sea of*.

Sea of Japan, Battle of the. See *Russo-Japanese War* (Last battles).

Sea otter is a furry animal that lives in the North Pacific Ocean. Herds of otters dwell near the shores of western North America and Siberia. They seldom leave the water.

The sea otter swims using its flipper-shaped hind feet as paddles. It eats and sleeps while floating on its back. Sea otters often sleep in masses of floating seaweed called *kelp*. The female carries her baby on her chest as she paddles about on her back. She has one baby, called a *pup*, at a time.

Most sea otters grow from 1.2 to 1.5 metres long and weigh from 27 to 39 kilograms. A large male, however, may weigh up to 45 kilograms. Sea otters have thick brown fur that traps air and keeps their skin dry. The fur also insulates them against the cold. A sea otter dives as deep as 55 metres for food and can stay under water as long as four minutes. It uses its front paws to grasp and hold, as do some otters that live in fresh water. For information about freshwater otters, see *Otter*.

Sea otters may eat as much as a fifth of their body weight every day. They feed on abalones, clams, crabs, fish, mussels, octopuses, sea urchins, and squids. Sea otters pry open shellfish in various ways. They use their teeth or their paws, and may pound one clam or mussel against another. A sea otter also may balance a rock on its belly and hammer the shellfish against it.



A sea otter swims mostly on its back, paddling with its flipper-shaped hind feet. The animal uses its front paws to grasp and hold objects, such as stones and shellfish. Sea otters live in the North Pacific Ocean.

For centuries, sea otters have been hunted for their valuable fur. From the mid-1700's through the 1800's, fur traders killed so many sea otters that the animal almost disappeared. In 1911, Canada, Japan, Russia, and the United States signed a treaty that prohibited the hunting of sea otters. As a result, the world's sea otter population is increasing steadily.

Scientific classification. Sea otters belong to the weasel family, Mustelidae. They make up the genus *Enhydra*, species *E. lutris*.

Sea plant. See Marine biology and its list of *Related articles*.

Sea rover. See Pirate.

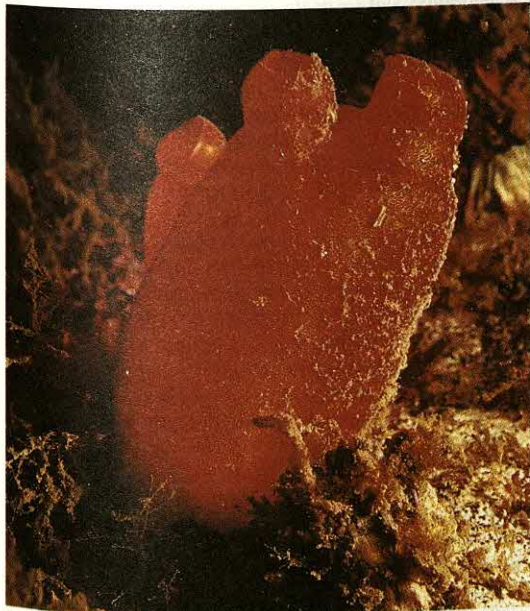
Sea serpent is a large, probably imaginary marine creature. Since ancient times, the legends of most peoples have told of such creatures as sea serpents, dragons, and unicorns. Witnesses have reported seeing sea serpents, but none of the snakelike monsters has ever been caught or washed ashore.

A sea serpent is probably just a group of leaping porpoises or a floating mass of giant seaweed. Other marine animals, including large eels, oarfish, sharks, and giant sea squids, have also been mistaken for sea serpents. Some scientists believe sea serpents may be the descendants of a prehistoric animal. The "Loch Ness Monster" is a famous sea serpent that supposedly has lived in a Scottish lake since the 500's. Photographs have been taken showing what has been claimed to be the "monster," but no conclusive evidence of its existence has been established.

See also Loch Ness Monster.

Sea shell. See Shell.

Sea squirt is a name for a group of sea animals which are also called *ascidians*. These animals have a habit of squirting out water through one of two body openings. Adult sea squirts have leathery bottle-shaped bodies. All



The sea squirt is a bottle-shaped sea animal. It lives its adult life attached to a fixed object on the ocean floor.

their adult lives they remain attached to stones, shells, and other fixed objects. Some sea squirts live together in colonies. The adult animal receives its food from water which it draws into the digestive tract through one of the body openings, called the *incurrent siphon*. It squirts out the water from the other opening, the *excurrent siphon*.

Sea squirts go through a larval stage before they become mature. The larva looks like a tadpole and can swim about. It has a *notochord* (elastic rod), that extends through the tail. Because of this "backbone," scientists think sea squirts are relatives of the simplest fishlike animals, *lancelets* and *lampreys*. In a few days, the larva loses its tadpole shape and settles on the ocean floor. Soon it develops its adult form.

Scientific classification. The sea squirt belongs to the phylum Chordata, subphylum Urochordata. It makes up the class Ascidiacea.

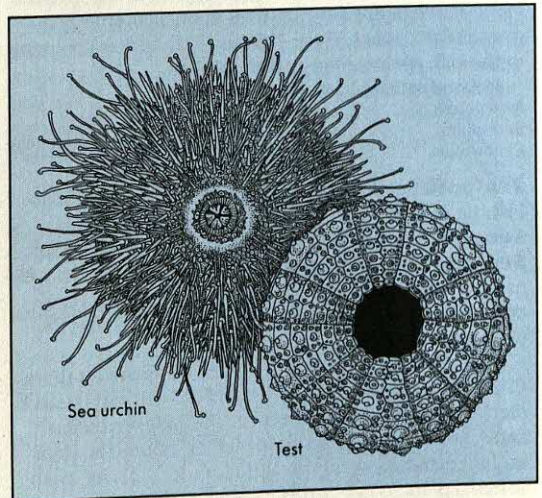
Sea star. See Starfish.

Sea turtle. See Turtle (Sea turtles).

Sea urchin is a sea animal related to the starfish and the sand dollar. Sea urchins have ball-shaped bodies covered with long, movable spines. Close-fitting skeletal plates lie under the animal's skin and form a shell called a *test*. The spines are attached to the test. Some sea urchins found on coral reefs have especially sharp spines that are dangerous to divers. Sea urchins may be black, brown, green, purple, red, or white. They measure from 5 to 12 centimetres in diameter. They live in oceans all over the world.

Sea urchins eat mostly plants found on rocks and on the sea bottom. A sea urchin's mouth is on the underside of its body. The animal scrapes up food with a set of five movable teeth. Some sea urchins can dig holes into rocks with their teeth.

A sea urchin moves by pushing with its spines or by using its tentaclelike *tube feet*, which have suction discs at the ends. In addition, the tube feet may function in respiration and as sense organs. Some sea urchins use their tube feet to cover themselves with old shells and



A sea urchin is covered by long, movable spines. The spines grow from a shell called a *test*, which lies just under the skin. The test protects the animal's soft body.

seaweed in order to hide from starfish and other predators. The reproductive organs of sea urchins are edible.

Scientific classification. Sea urchins belong to the phylum Echinodermata, class Echinoidea.

Sea wasp is a dangerous stinging jellyfish with a strong, box-shaped body 5 to 15 centimetres in diameter. In Australia, sea wasps are found in the waters of Queensland's northern and northeastern coasts, but are not common in the offshore Barrier Reef islands. Sea wasps have four bunches of tentacles at each corner that may reach 1.5 metres in length. The tentacles contain masses of tiny capsules, each with a poisoned dart that shoots out and can pierce human skin. Severe stinging may result in extreme pain and death within minutes.

Scientific classification. The sea wasp belongs to the family Charybdeidae. It is *Chironex fleckeri*.

Seaborg, Glenn Theodore (1912–), an American chemist, became known for contributing to the discovery of several elements heavier than uranium. Seaborg and his associate, Edwin M. McMillan, shared the 1951 Nobel Prize for chemistry for the discovery of the elements plutonium (Pu), americium (Am), curium (Cm), berkelium (Bk), and californium (Cf). Seaborg later contributed to the discovery of einsteinium (Es), mendelevium (Md), and nobelium (No). All of these elements are radioactive, and all are artificially created.

Seaborg made the first of his discoveries in 1940. That year, he and his associates at the University of California in the United States created plutonium by bombarding a sample of uranium with nuclear particles. This process produced a change in the nucleus of the uranium, *transmuting* the uranium into plutonium (see **Transmutation of elements**). Similar techniques were later used to produce other transuranium elements. In addition, Seaborg's isolation of plutonium 239, an isotope that readily undergoes *fission* (splitting) when struck by neutrons, served as the basis for the development of the plutonium atomic bomb (see **Plutonium**).

Seaborg was born in Ishpeming, Michigan, U.S.A. He received a Ph.D. in chemistry from the University of California in 1937. After World War II ended in 1945, he became active in the development of nuclear energy for peaceful purposes. From 1961 to 1971, he was chairman of the U.S. Atomic Energy Commission.

Related articles in *World Book* include:

Americium	Curium	Nobelium
Berkelium	Einsteinium	Transuranium element
Californium	Mendelevium	

Seafood. See **Fish** (The importance of fish). See also **Fishing industry** and its list of *Related articles*.

Seagull. Any gull found on or near the sea. See **Gull**.

Seah Eu Chin (1805-1883), a Chinese businessman, became a wealthy plantation owner in Singapore. As a community leader, he was respected by both the Chinese and the British.

Seah Eu Chin was born in Swatow, Fujian, Southern China. He arrived in Singapore in 1823. He worked as a clerk on board trading *junks* (small Chinese vessels). Later, he set up his own shop, selling goods for ships, and importing tea, cotton, and cloth. In 1835, he established a plantation to grow pepper and *gambier*, a tropical, Asian shrub. Gambier leaves were used for tanning and dyeing cloth in the 1800's. Gambier became one of Singapore's main exports.

Seah Eu Chin was appointed a justice of the peace. In 1849, at the request of the government, he took action to stop riots and fighting caused by quarrelling among Chinese secret societies. After he retired from business, he devoted himself to the study of Chinese literature.

Seahorse is a small fish that is so named because its head resembles that of a tiny horse. About 25 species of seahorses live in shallow tropical seas. Some species also are found in temperate waters. Most seahorses are less than 15 centimetres long. A species of seahorse from the Pacific region may reach a length of 30 centimetres. Seahorses belong to the same family as pipefishes (see **Pipefish**).

A seahorse's body is made up of bony plates. The fish has a long snout and feeds by sucking small animals into its cylindrical mouth. The tail is long, flexible, and capable of grasping. Seahorses use their tails to cling to rooted plants or floating sea vegetation. Baby seahorses often form small groups by holding onto each other with their tails. A seahorse's large *swim bladder* holds air and enables the fish to stay at a certain depth. A seahorse swims weakly, using its *dorsal fin* (back fin) and *pectoral fins*. The pectoral fins, located at the side of the head, look like a pair of ears.

Seahorses have an unusual way of reproducing. The male has a special pouch in which the female lays eggs. The male later releases tiny, live young.

Scientific classification. Seahorses belong to the family Syngnathidae, and are genus *Hippocampus*.

Seal is a sleek sea mammal with a body shaped like a torpedo. Seals are excellent swimmers and spend much time in the water. But they give birth to their young on land. Most kinds of seals live in the oceans or in inland seas, but a few live in fresh water. The Baikal seal, for example, lives in Lake Baikal in Russia. Seals are especially plentiful in polar seas, but they are less common in tropical waters.

Some kinds of seals, including harbour seals and ringed seals, spend much of their time on land or on floating chunks of ice. But northern fur seals stay at sea for eight months. They *migrate* (travel) about 8,000 kilometres a year—farther than any other seal. They swim south from the Bering Sea almost to northern Mexico, and then return north. During the entire trip, the seals swim 15 to 160 kilometres from the coast and never go ashore. No one knows why the seals make their yearly trip.

The largest seal is the southern elephant seal, which lives off Antarctica and in the sub-Antarctic waters off South America. The male may grow to be 6.5 metres long and may weigh up to 3,600 kilograms. This seal ranks second in size only to whales among all sea mammals. The smallest seal is the ringed seal of the Arctic. It is about 1.5 metres long and weighs up to 90 kilograms. People hunt some kinds of seals chiefly for their fur.



Seahorse



Many northern fur seals spend the summer on Alaskan islands and travel south for the winter.

After the fur has been removed, the seal meat is sometimes frozen and sold as animal food.

Some Eskimos and other Alaskans eat seal meat. The meat has such a strong flavour that most people in other parts of the world do not like it. Seal blubber is used for cooking, or is burned for light and heat. Eskimos also make hunting clothes from the skins of ringed seals, and use walrus hides to cover the wooden frames of their boats. They stretch the intestines of seals and sew them together in strips to make raincoats.

Seals make up a group of mammals called *Pinnipedia*. This name comes from Latin words meaning *fin-footed*. A seal's flippers look somewhat like fins.

There are three main groups of pinnipeds: (1) eared seals, which include fur seals and sea lions; (2) earless seals, including harbour seals and elephant seals; and (3) walruses. An earless seal has small ear openings, but no ears on the outside of its body. Walruses also have small ear openings but no outside ears. They are the only pinnipeds with tusks.

The body of a seal

Most kinds of seals have hair on their bodies, but some adult male walruses are almost hairless. Fur seals have thick coats of fine hair. Like all other mammals with fur, seals shed their coats every year and grow new ones. Most species of seals shed a few hairs at a time, much as cats and dogs do. But elephant seals lose large pieces of skin and hair and look ragged.

All seals have a layer of blubber 2.5 to 15 centimetres thick. It helps keep the animals warm, and gives them energy when they can get no food.

Head. Some kinds of seals have small heads with short noses that give their faces a "pushed in" appearance. An elephant seal has a long, curved nose. The male hooded seal's nose forms a pouch that extends

over the top of its head. When the animal is annoyed, it blows air into the pouch. The outer skin of the pouch expands like a balloon, and forms a bright red hood on the animal's head. The seal uses its hood to frighten enemies. All seals have slitlike nostrils, which they close when they swim under water.

The eyes of most species of seals are large and shiny, but walruses have small eyes. Most seals can see and hear well, but they have a poor sense of smell. All seals have whiskers on the upper lip. The whiskers are sensitive to touch and probably help seals in their hunt for food.

Flippers. Seals have four legs, but the leg bones above the ankles are buried inside the body. The parts that extend outside, including the feet, form the animal's large, paddlelike flippers. The front flippers of fur seals and sea lions are longer and flatter than those of other species. A fur seal's front flippers may be more than 45 centimetres long and 15 centimetres wide, and help

Facts in brief

Names: male, bull; female, cow; young, calf, pup, or whelp; group, herd or pod.

Gestation period: About 8 to 12 months, depending on the species.

Number of newborn: Usually 1, rarely 2.

Length of life: 40 years or more.

Where found: Along the coasts of continents in most parts of the world; a few kinds in freshwater lakes and inland seas.

Scientific classification: Seals make up a group of animals called the *pinnipeds*. Some zoologists consider the seals a separate order, Pinnipedia. Seals may also be placed in the order Carnivora, together with bears, cats, and dogs. Fur seals and sea lions belong to the eared seal family, Otariidae. Walruses belong to the walrus family, Odobenidae. Elephant seals and harbour seals belong to the earless seal family, Phocidae.

make this animal a powerful swimmer. The front flippers of earless seals are smaller and narrower than those of fur seals. Earless seals swim by moving their bodies and rear flippers much as fish move their bodies and tails. A frightened fur seal can swim as fast as 16 kilometres per hour for about five minutes.

Fur seals, sea lions, and walruses turn their rear flippers forward and downward to help support their bodies on land. They walk on all four flippers. The rear flippers of earless seals extend straight back, palm to palm. These seals cannot turn their flippers forward. They move themselves across land or ice by rhythmic contractions of their strong belly muscles.

The life of a seal

Most kinds of seals live in groups and may stay together on long ocean journeys. A few species, including the Ross seals of the Antarctic, live alone or with only two or three other seals. Some species, including grey seals and ringed seals, are known to live for 40 years or more.

Seal rookeries. Every spring, seals go to their breeding grounds, called *rookeries*, to have young and to find mates. Most rookeries are on islands. Rookeries of northern fur seals are large beach areas, and more than 150,000 seals may gather at one rookery.

The northern fur seal *bulls* (males) are the first to arrive at the rookeries. Late in May their bellows and roars can be heard over 1.5 kilometres away as they fight for their choice of places, called *territories*, along the beach. The *cows* (females) come ashore in early July and join the *harem* (group of females) of one of the bulls. A bull's harem will usually consist of from 3 to more than 40 cows, but a few bulls may have harems of over 100 cows. Shortly after a cow arrives on shore, she gives birth to the baby she has carried inside her body for about 12 months. The cow will mate again a few days after the birth of her baby.

Bull seals fight to get their territories. They defend their territories and the cows within them. Bulls are not strong enough to hold a territory until they are about 10 years old. The young bachelors, and older bulls without harems, live apart from the others. Most cow seals bear their first young when they are about 5 years old, and usually give birth each year. Some cow seals may bear young until they are 25.

Young. A female seal almost always has one *pup* (baby seal) at a time. Twins are rare. A newborn pup has teeth that are *erupting* (breaking out of the gums), and fine, soft fur covers its body. Sea lion pups have brown fur, and newborn fur seals, elephant seals, and monk seals have black coats. The pups of harp seals, leopard seals, walruses, and other seals that live on floating islands of ice may be white, greyish, or brown.

Northern fur seal pups can swim and can travel on land as soon as they are born. The mothers divide their time between eating at sea and nursing their pups on land. A mother may stay at sea from seven to nine days. After she returns, she hunts for her pup among the hundreds of others on the beach. Each mother feeds only her own pup, which she recognizes by its cry and its odour. The pup gets enough milk from its mother to stay alive until its next feeding. Seal milk is rich, and the pups grow quickly. A fur seal weighs about 4.5 kilo-

grams at birth and from 14 to 16 kilograms when its mother leaves it, 3 or 4 months later.

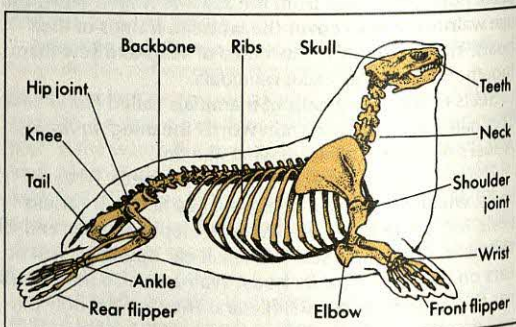
Food. Seals feed on various marine animals. Fur seals and sea lions eat primarily fish and squid, and harbour seals eat mostly fish and octopus. Crab-eater seals and ringed seals feed mainly on small shrimp. Elephant seals prefer small sharks and rays, which they capture in deep water, and leopard seals feed on fish and sometimes on penguins. Walruses eat clams.

A seal has sharp, pointed teeth with which it grasps and tears most of its prey. It cannot chew food because its teeth have no flat surfaces. It swallows small fish whole.

Enemies. The seal's greatest enemy is the hunter. For hundreds of years, hunters have killed seals for blubber, bones, fur, and meat. During the 1800's, so many seals were killed that only a few survived. Several nations quarrelled about how northern fur seals should be hunted. In 1911, Canada, Japan, Russia, and the United States signed an agreement to protect northern fur seals. That year, there were only about 150,000 northern fur seals on the Pribilof Islands in the Bering Sea, which hosts the world's largest breeding herds. Today, there are about 870,000.

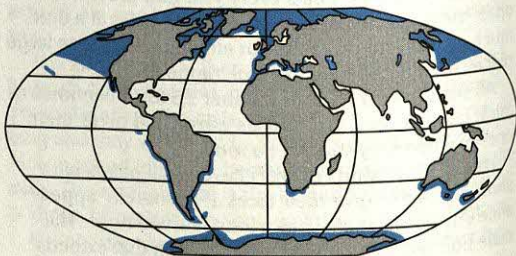
The yearly harvest of skins ranged from 20,000 to 24,000. Under the agreement, seals were hunted commercially only on land. Canada and Japan did not hunt northern fur seals because none of the rookeries were in their territory. The Soviet Union and the United States each gave 15 per cent of their catch to Canada and 15 per cent to Japan. In this way, the catch was shared by all the nations in whose territory the seals live. Since

The skeleton of a seal



Where seals live

The blue areas of the map show the parts of the world where seals are found. Most seals live in the Northern Hemisphere.

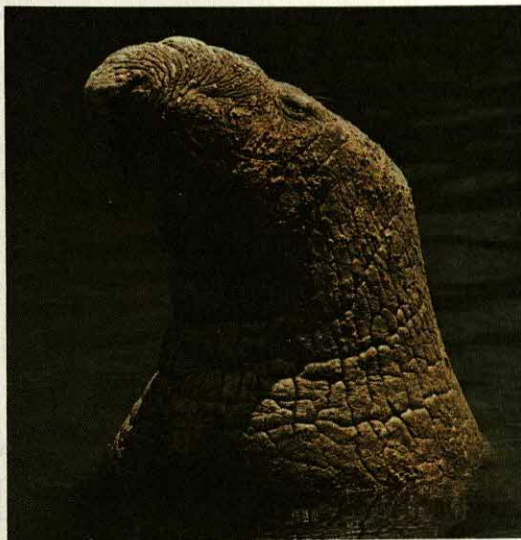


1984, animal protection laws have ended all commercial harvesting of seals on the Pribilof Islands.

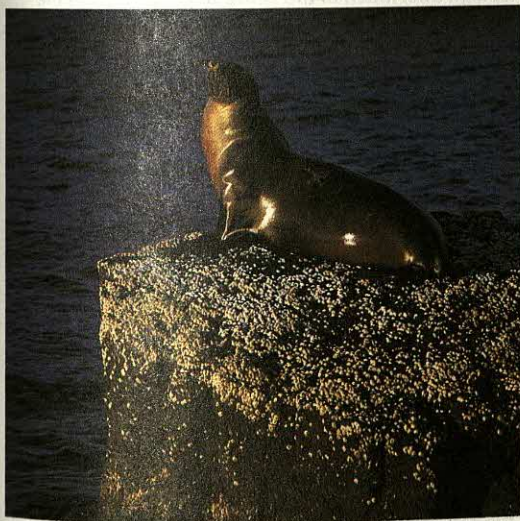
Several species of fur seal are found in the Southern Hemisphere. The Australian subspecies of the Cape fur seal is the largest; males grow to 2.5 metres long and many weigh 300 kilograms. Southern fur seals are now protected by law.

Several other species of seals are hunted for their fur or hides. The yearly harvest of newborn harp seals off the coast of Newfoundland ranked as one of the best-known seal hunts. Newborn harp seals—often called *whitecoats*—are prized for their soft white fur, which they shed within a month after birth. Many people opposed the annual whitecoat hunt. In 1983, several European countries banned the importation of whitecoat pelts. This action resulted in a significant decline in the number of whitecoats killed. By 1985, large-scale harvesting of whitecoats off Newfoundland had ended.

Seals have few enemies besides human beings. Large sharks and killer whales attack them in the water, and



The **elephant seal**, also called the *sea elephant*, is named after its large nose, which grows about 38 centimetres long. The tough skin also looks somewhat like elephant hide.



The **Galapagos sea lion**, a subspecies of the California sea lion, is found only on the Galapagos islands, that lie about 1,000 kilometres off the coast of Ecuador.

polar bears hunt seals on ice. A seal has few defences against its enemies. In the water, it usually tries to escape an attacker. Some species swim among the strong waves and between the large rocks close to shore, where most of their enemies cannot follow. Other species take deep dives when an enemy approaches.

Many kinds of seals are so slow and clumsy on land or ice that they have little chance of escaping an enemy. The crab-eater is one of the fastest seals on land or ice. Crab-eater seals can move about 25 kilometres per hour—almost as fast as a person can run.

Related articles in *World Book* include:

Animal (Animals and their young (picture))	Hand
Antarctica (Animal life)	Mammal
Bering Sea controversy	Pribilof Islands
Eskimo	Territoriality
	Walrus

Seal is a device with a design or lettering for *impressing* (stamping) on paper, wax, or metal. Seals are often attached to official and important documents to prove that they are trustworthy. Most countries in the world and many cities, states, provinces, important officials, and commercial enterprises have seals.

The *matrix* (mould) of a seal may be made of paper, metal, or gem. It may consist of two pieces, the *baso* (bottom) and *alto* (top). The matrix is used for stamping one design on paper. It can also be used to stamp different designs on the *obverse* (front) and the *reverse* (back) of wax or lead. In early times, kings and other officials wore signet rings. They pressed the design of the ring on hot wax to make a seal.

See also **Babylonia** (Art); **Sealing wax**.

Sealing wax is used for sealing letters and documents and for taking the impression of seals (see **Seal**). The wax may be made of rosin, shellac, turpentine, magnesia, chalk, or gypsum. Wax also may be used for sealing bottles and jars.

Before envelopes with gummed flaps were invented, sealing wax was used to seal letters. Wax used for letters and documents is coloured with vermilion, a red colouring matter. It is sold in a stick form. An inferior grade of sealing wax used for sealing packages is usually coloured with lampblack.

Sealyham terrier is a strong, white, short-legged dog with a long head, powerful jaws, and big teeth. It is good at catching rats and mice. This dog stands about 28 centimetres high and weighs 10 to 11 kilograms. The Sealyham terrier was first bred about 1850 at Sealyham, an estate in Pembrokeshire, Wales. It was once used in Wales to frighten badgers, foxes, and otters from their burrows. If necessary, the Sealyham terrier would go into the burrow and drag the animal out.

See also **Dog** (picture: Terriers).

Séance. See **Spiritualism**; Mesmer, Franz.

Seaplane. See **Aeroplane** (Aeroplanes of today).

Seaport. See **Harbour**; **Port**.

Search, Right of. See **Right of search**.

Search warrant is a document issued by a court, which permits a police officer to search a house or other building. It is issued if there is reasonable cause to believe that illegal equipment or stolen goods are there. The power to issue search warrants is contained in statutes relating to many different crimes. Some of the things that may be searched for are illegal firearms and explosives; controlled drugs and documents relating to them; obscene publications; equipment used for counterfeiting, forgery, illegal gambling, or distilling alcohol without a licence; and animals that are kept in cruel conditions.

The conditions under which a warrant is issued depend on the statute granting the power. Normally, the premises to be searched must be named and the search will be carried out by police officers. There may be restrictions as to the time of day the search can be made and the amount of force that can be used to break into the premises. Some warrants include a power to arrest people on the premises. The warrant authorizes the seizure of property connected with the offence to which the statute relates. However, police officers also have a right to seize other property found on the premises if it is connected with a separate offence.

Searle, Ronald (1920-), an English artist, cartoonist, and designer, became popular as the creator of the weird young ladies of the fictional school of St. Trinian's.



"We'd better have her examined—she's resolved to be good."

Searle was born in Cambridge and studied art there. The drawings he made as a Japanese prisoner of war established him as an artist.

Sears, Roebuck and Company is the world's largest retail business firm. Its Merchandise Group operates about 800 department stores and approximately 2,400 catalogue sales centres throughout the United States. Associated companies operate more than 100 Sears stores in Canada and Mexico.

In addition, the Sears Financial Network operates financial centres in more than 300 Sears stores in the United States.

In 1886, Richard W. Sears, a 23-year-old railway station agent, began to sell watches by mail from North Redwood, Minnesota, U.S.A. Sears moved to Chicago the next year and hired Alvah C. Roebuck to repair customers' watches. The two men became partners, and in 1893, they founded Sears, Roebuck and Company. The firm sold many kinds of products, all by mail-order catalogue. The first catalogue was published in 1894. During the early 1900's, Sears, Roebuck and Company became the world's largest mail-order company.

In 1925, Sears opened its first retail store, in Chicago. In 1931, sales from Sears's retail stores topped the firm's mail-order sales for the first time.

Today, Sears distributes about 320 million catalogues a year. The firm has more than 450,000 employees. Its headquarters are in Chicago, in Sears Tower, the world's tallest building.

See also **Mail-order business**; **Retailing**.

Seashore is the place where the land and the sea meet. It is an area of continual change. As the sea rolls in at high tide, much of the shore becomes part of the ocean. At low tide, the sea retreats and the same area again becomes part of the land. But in spite of this ever-changing environment, the seashore supports a great variety of living things. Many of these organisms live nowhere except along the ocean's edge.

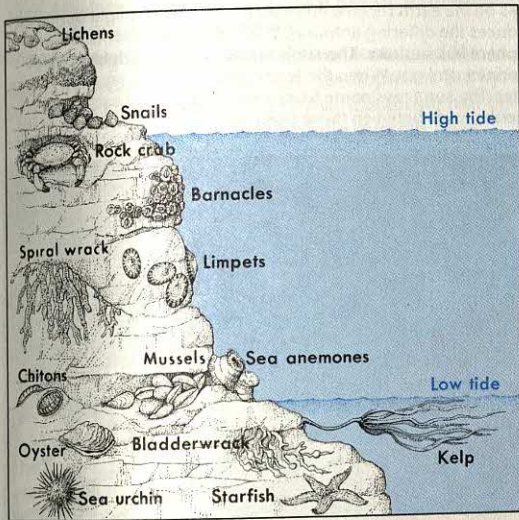
A mass of tiny organisms, called *plankton*, play an important role in the life of the seashore. These organisms swim or float on the ocean tide. Many of them remain part of the plankton for their entire life, but others grow into larger animals of the seashore. Most large seashore animals start their existence as *larvae*, planktonic creatures that bear little resemblance to their parents. Most larvae die, but some of them land on a suitable shore and grow into adults.

Plankton serves as more than a nursery for seashore life. As the waves of the ocean sweep across the shore, they carry with them a feast of plankton. Many seashore animals feed on these tiny organisms. Such creatures as barnacles, mussels, oysters, and sponges spend their adult life permanently attached to the shore. They eat the plankton when it comes to them. Other animals, including clams and worms, burrow into the shore and collect food from water containing plankton. Even various shorebirds that feed on the plankton-eating creatures rely indirectly on the plankton.

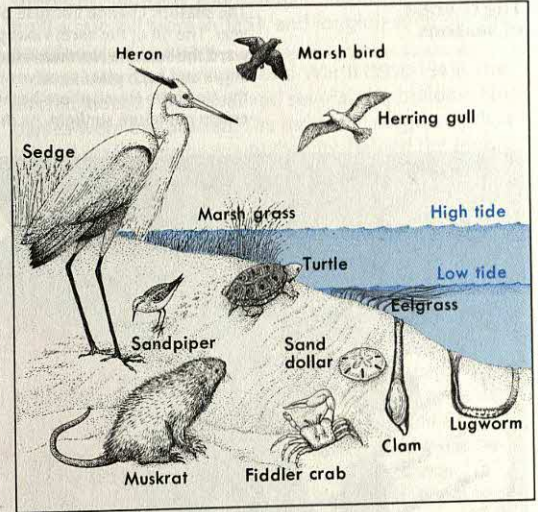
Scientists classify seashores into three main types, depending on their surface: (1) rocky shores, including coral reefs; (2) muddy shores; and (3) sandy shores. Characteristic groups of organisms live on each type of shore.

Life on rocky shores is more plentiful than on any other type of seashore. Great numbers of organisms crowd the hard, rough surfaces of coral reefs and wave-scarred cliffs. These organisms must withstand powerful waves that could wash them away or crush them on the rocks.

Most organisms that live on rocky seashores have special features that hold them securely to the rocks and coral. Many adult animals, including barnacles, mussels, oysters, sea squirts, and sponges, permanently anchor themselves to the shore. Others, such as chitons, limpets, sea anemones, sea urchins, and starfish, also attach themselves firmly to the shore. But these creatures are capable of moving short distances.



A variety of organisms live along the seashore. Most of those found on rocky coasts, *left*, have special features that enable them to cling tightly to the shore. In this way, they avoid being washed away or broken on the rocks by waves. Most of the animals of muddy shores, *right*, burrow into the soft ground to escape the waves. At low tide, a number of species of birds and mammals visit muddy shores to feed on the burrowing creatures.



Some animals, including plantlike *bryozoans* and *hydroids*, have flexible bodies that bend with the motion of the waves. Large seaweeds, such as *kelps* and *rockweeds*, cling to the shore with structures called *holdfasts*. Many species of worms and other creatures burrow into the rock and coral, and others wedge themselves tightly into cracks.

When the tide goes out on a rocky shore, small pools of water remain behind. These *tide pools* provide a refuge for crabs, fish, and other seashore creatures that need to remain in seawater. Such animals live in the tide pools until the incoming tide again covers the shore.

Most animals that live on rocky shores eat plankton. A few, including rock crabs and starfish, feed on the creatures that eat the plankton. Water plants and algae create their own food in a process called *photosynthesis* (see *Photosynthesis*).

Life on muddy shores. Most muddy seashores lie in bays, where they are protected from strong waves. Rivers empty into many of these bays, decreasing the saltiness of the sea water. Plants—including various grasses and, in the tropics, mangrove trees—thrive along muddy shores. Crabs, mudskippers, and turtles live among these plants. Clams and various worms burrow into the muddy bottom.

Life on sandy shores. Sandy beaches have fewer forms of life than do rocky or muddy shores. Most plants and animals cannot attach themselves strongly enough in the loose sand to withstand the effects of waves and currents. Most of the animals of sandy shores—including shelled molluscs, such as clams, cockles, and razor shells, ghost crabs, mole crabs, sand dollars and shrimps—burrow under the sand. Few plants live on sandy shores between the levels of high and low tide.

See also *Ocean* (Life in the ocean; The changing shoreline).

Seasickness. See Motion sickness.

Season is one of the four periods of the year. Each season—spring, summer, autumn, and winter—lasts about three months and brings changes in temperature, weather, and the length of daylight.

During the spring, the days are warm in middle parts of the Northern Hemisphere, the northern half of the earth. Summer follows with hot days and warm nights. In autumn, the days become cooler, leading to the cold of winter. The four periods are called *climatic seasons* when based on these temperature and weather changes.

In the Southern Hemisphere, the climatic seasons differ by about six months. This hemisphere has summer when the Northern Hemisphere has winter.

Some regions do not have all four climatic seasons. In parts of the tropics, for example, temperatures change little. But the amount of rainfall varies greatly, so that these regions have a wet season and a dry season. The

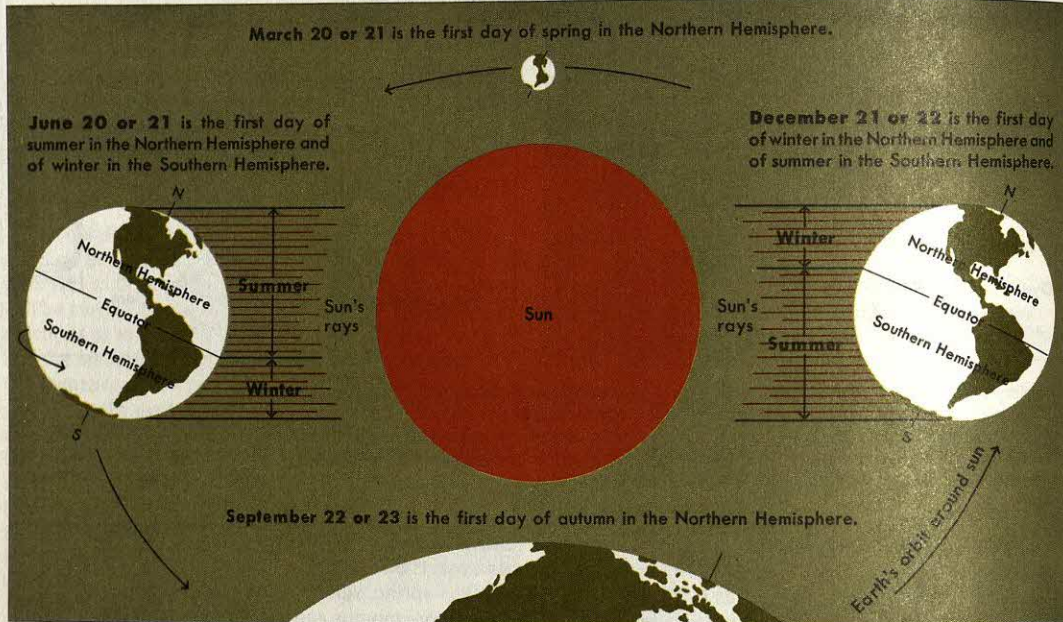
First day of the astronomical seasons in the Northern Hemisphere*

Year	Spring	Summer	Autumn	Winter
1987	March 20	June 21	Sept. 23	Dec. 22
1988	March 20	June 20	Sept. 22	Dec. 21
1989	March 20	June 21	Sept. 22	Dec. 21
1990	March 20	June 21	Sept. 23	Dec. 21
1991	March 20	June 21	Sept. 23	Dec. 21
1992	March 20	June 20	Sept. 22	Dec. 21
1993	March 20	June 21	Sept. 22	Dec. 21
1994	March 20	June 21	Sept. 23	Dec. 21
1995	March 20	June 21	Sept. 23	Dec. 21
1996	March 20	June 20	Sept. 22	Dec. 21
1997	March 20	June 21	Sept. 22	Dec. 21
1998	March 20	June 21	Sept. 22	Dec. 21
1999	March 20	June 21	Sept. 23	Dec. 22
2000	March 20	June 20	Sept. 22	Dec. 21

*Central Standard Time.

The change of seasons

The seasons change because places on the earth receive different amounts of sunlight during the year. The tilt of the earth's axis produces the differing amounts. When the North Pole is tilted toward the sun, the Northern Hemisphere has summer. The sun's rays strike the earth from a high angle and each place receives maximum sunlight. When the North Pole is tilted away from the sun, the Northern Hemisphere has winter. The sun's rays come from a lower angle and each place receives minimum sunlight. As the earth moves between these positions, autumn and spring occur.



polar regions, on the other hand, have a light season and a dark season. In these parts of the world, the sun shines almost all the time in summer and almost never during the winter.

The changing seasons are caused by the changing position of the earth in relation to the sun. Astronomers can tell exactly from the earth's motion around the sun when one season ends and the next one begins. The dates used for the first day of each season mark the beginning of the *astronomical seasons*. The beginning and end of the climatic seasons vary from these dates from place to place and from year to year. The temperature and weather do not change instantly in response to the changing position of the earth in relation to the sun. The warmest and coldest weather generally occurs several weeks after the beginning of the summer and winter astronomical seasons. Heat that has been retained by the oceans plays an important role in producing this delayed response.

The seasons keep changing because the tilt of the earth's axis never changes while the earth circles the sun. One way to understand this is to picture which way the tilt of the axis causes the North Pole to slant at different times of the year. When the North Pole slants toward the sun, the Northern Hemisphere receives the most sunlight and it is summer there. When the pole slants away from the sun, the Northern Hemisphere receives the least sunlight and it is winter. Spring begins when the pole starts to slant toward the sun, and autumn begins when the pole starts to slant away again.

Summer begins in the Northern Hemisphere when

the *summer solstice* occurs, on June 20 or 21. The sun is high in the sky and there are more hours of daylight than on any other day. The *winter solstice* marks the beginning of winter in the Northern Hemisphere. It occurs on December 21 or 22. The sun is low in the sky and there are fewer daylight hours on that day than on any other day.

The *vernal equinox* marks the beginning of spring, on March 20 or 21. Autumn begins on September 22 or 23, the *autumnal equinox*. At both points, the sun appears directly above the equator. During each equinox, places on the earth have approximately 12 hours of daylight and 12 hours of darkness.

Related articles in *World Book* include:

Autumn	Equinox	Solstice	Summer
Calendar	Indian summer	Spring	Winter

SEATO. See **Southeast Asia Treaty Organization.**
Seattle (pop. city—516,259, metropolitan area—1,972,961) is the largest city in Washington, United States. It is an important manufacturing, trade, and transportation centre of the Pacific Northwest. The city lies on the east shore of Puget Sound, about 200 kilometres from the Pacific Ocean via the Strait of Juan de Fuca. Seattle's location has helped make it a gateway to Alaska and the Far East. About two-fifths of the people of Washington live in the Seattle metropolitan area.

In 1851, pioneers from Illinois founded a settlement along Puget Sound on Alki Point. They chose this site because of the area's many natural resources, including plentiful timber and water. The next year, they moved the settlement inland to the shores of Elliott Bay. They

named their town Seattle after Chief Sealth, a Duwamish Indian who had befriended them.

The cutting and shipping of timber accounted for much of the city's early economic development. But by World War II (1939-1945), aircraft manufacturing had become Seattle's chief source of income. Aircraft sales began to decline during the late 1960's, and thousands of workers lost their jobs. However, Seattle and the aircraft industry recovered from this economic setback during the 1970's.

About 90 per cent of Seattle's people were born in the United States, and about 5 per cent have Scandinavian ancestry. Blacks and other minority groups, including American Indians and Asians, make up about 20 per cent of the population. Most of the minority groups live in the city's central and southern sections, where poverty is a problem.

Manufacturing provides much of Seattle's income. The Boeing Company, one of the largest U.S. aircraft producers, has more employees than any of the other 3,600 manufacturers in the area. In mid-1968, about 100,000 people worked for Boeing.

Employment in another major industry, logging, also declined during the late 1960's because of a slowdown in housing construction. Other major manufacturing industries in Seattle produce cement, clay, fishing supplies, flour, metal products, textiles, and food products.

The Port of Seattle handles about 8 million metric tons of cargo yearly. Seattle is the principal supplier of food products to Alaska and a major importer and distributor of Alaskan canned salmon. Seattle has a large fishing fleet and is famous for its halibut catch.

In 1852, a group of Illinois pioneers settled on the

shores of Elliott Bay and founded Seattle. Henry Yesler built a sawmill there in 1853, and logging soon became Seattle's chief industry.

Seattle thrived during World War II (1939-1945). The aircraft industry boomed, and several shipbuilding companies were established. The industrial surge, which attracted many newcomers to the city, helped the population rise from 368,000 in 1940 to more than 467,000 in 1950. By 1960, Seattle had 557,000 people.

During the 1960's, a large number of families moved from Seattle to the suburbs. As a result, the city's population decreased between 1960 and 1980, but the population of the metropolitan area increased.

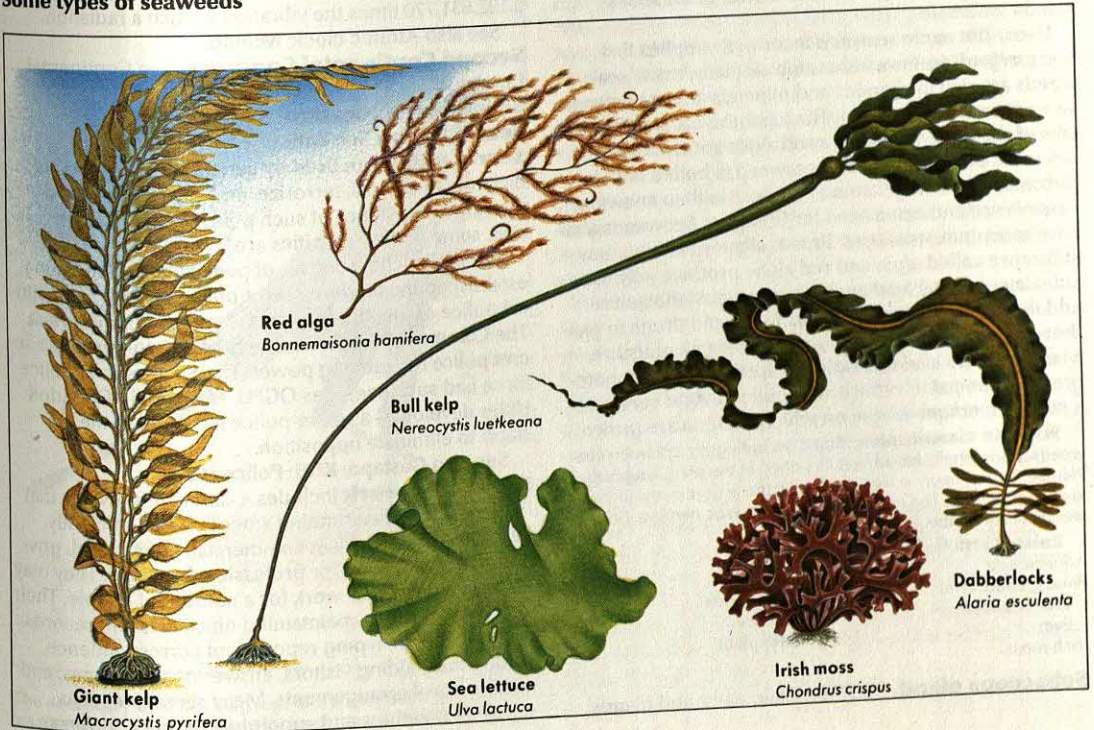
A sharp decrease in aircraft sales during the late 1960's and early 1970's hurt the city's economy. In 1971, Seattle's unemployment rate—about 13 per cent—was higher than that of any other U.S. city. However, later in the 1970's, the aircraft industry recovered, and Seattle businesses began to benefit from increased trade between the United States and Far Eastern nations.

Seawater, Purification of. See Water (Fresh water from the sea).

Seaweed is a name applied to almost any plantlike marine organism that is large enough to be seen with the unaided eye. Seaweeds can be found growing in underwater beds, floating on the sea surface, attached to rocks and piers, and washed up on shore.

Like most plants, seaweeds contain a green pigment (colouring matter) called chlorophyll. Chlorophyll enables seaweeds to make their own food through *photosynthesis*, the process by which plants and certain other organisms use energy from sunlight to turn carbon dioxide and water into sugar. This sugar not only fuels the

Some types of seaweeds



seaweeds own growth and development, it also serves as food for animals that feed on seaweeds. Seaweeds also help provide sea animals with oxygen, which is released as a by-product of photosynthesis. In addition, many marine creatures, including a wide variety of fish, find shelter in seaweed beds.

Kinds. There are about 7,000 species of seaweeds. All of the species are simple organisms called *algae* (see *Algae*). Algae lack true roots, stems, leaves, and flowers. However, their special structure suits seaweeds to a life of pounding by the sea.

Marine algae can be found from the polar seas to the tropics. Most varieties grow near coasts, where they are attached to rocks, shells, or the floor of the sea. A root-like part, called a *holdfast*, anchors larger seaweeds to solid objects and prevents them from being washed away. Unlike a true root, the holdfast is not specialized to absorb water and minerals.

A *frond*, which resembles a stem and leaf, extends from the holdfast. The soft, flexible fronds of a seaweed can sway with the water without being torn apart. Some seaweeds have gas-filled swellings on their fronds. These swellings keep the frond afloat.

Seaweeds belong to the brown, red, and green algae groups. Most brown algae prefer cold water, where they may grow extremely large. For example, the *giant kelp* found off the coast of California reaches lengths of up to 60 metres. Brown algae called *gulfweeds* prefer warm water. Gulfweeds grow in large, floating masses over an area of the North Atlantic Ocean known as the Sargasso Sea. Most red algae are small and delicate, with a feathery appearance. They prefer warm water, and they are particularly abundant in tropical and subtropical seas. Green algae grow in both warm and cold seas. The greatest variety of green algae seaweeds is found in shallow tropical waters. Most of these seaweeds are small.

Uses. The name *seaweed* incorrectly implies that these organisms have little value. Actually, many seaweeds are rich in vitamins and minerals and are eaten in various parts of the world. The Japanese eat several species of seaweed. In Wales, a red algae known locally as *Laver* is a popular food. The seaweed is boiled until it becomes a brown gelatinous purée. It is then known as *Laver bread* and eaten fried for breakfast. Seaweeds also have many industrial uses. Brown algae yield a gummy substance called *algin* and red algae produce jellylike substances called *agar* and *carrageenin*. Manufacturers add these substances to various foods and drugs to give them a smooth texture and help them retain moisture. Manufacturers also use algin in lipsticks, soaps, photographic film, paint, varnish, and buttons. Agar serves as a *culture medium*, a base on which bacteria are grown.

Scientific classification. Algae, including the common seaweeds, traditionally have been classified in the plant kingdom, *Plantae*. Today, many scientists classify these organisms in the kingdom *Protista*. The giant kelp is *Macrocystis pyrifera*. Gulfweeds make up the genus *Sargassum*.

Related articles in *World Book* include:

Aquaculture	Kelp
Food (picture:	Sargasso Sea
Where people	Seashore
(live)	Water plant
Irish moss	

Sebaceous gland. See *Skin* (Hair, nails, and glands).

Sebastian, Saint (died A.D. 288), was an early Christian martyr. Legends about him were made famous by painters of the Renaissance. According to these legends, Saint Sebastian entered the Roman Army without revealing his intent to assist and protect the Christians. The Emperor Diocletian liked him and made him commander of soldiers in Milan. But Sebastian's religious faith was discovered, and he was condemned to death. A troop of soldiers tied him to a tree and shot him with arrows. They thought him dead and left him. He was cared for by a Christian woman named Irene. Sebastian again declared his faith after he recovered. The emperor then ordered him clubbed to death in the amphitheatre. Saint Sebastian tied to the tree was a favourite subject of early Italian painters. His feast day is January 20.

Sebastopol. See *Sevastopol*.

Seborrhoea. See *Dandruff*.

Secession. See *American Civil War*.

Secondal. See *Barbiturate*.

Second, a unit in the metric system, is used to measure time and angles. Its symbol is *s*. In measuring time, 60 seconds make up 1 minute. There are 60 minutes in 1 hour, and 24 hours in a day, and so a second is $\frac{1}{86,400}$ of a day. In measuring angles, 60 seconds make up 1 minute, and there are 60 minutes in 1 degree. A circle is divided into 360 degrees, so a second is $\frac{1}{1,296,000}$ of a circle.

A second of time equals an exact fraction of a day. But days are not equal in length because the earth does not travel in a perfect circle around the sun. Therefore, measurements of time based on the day are not constants and cannot be used for scientific work. Scientists used an atomic clock in establishing a measurement standard for time. This measures intervals of time according to the number of vibrations made by a form of radiation from a caesium atom. A second is defined as 9,192,631,770 times the vibration of such a radiation.

See also *Atomic clock*; *Minute*.

Second Continental Congress. See *Continental Congress*.

Secondary education. See *Education*.

Secret ballot. See *Ballot*.

Secret police are used by certain governments and dictators to control, terrorize, and spy on people. Although the existence of such police forces is rarely a secret, some of their activities are.

Joseph Fouché, minister of police under Napoleon I, established the modern secret-police system. The political police of the Russian czars was called the *Okhrana*. The Communist leaders of the Soviet Union used the secret police for keeping power. The Soviet secret police force had such names as OGPU, MVD, and KGB. Adolf Hitler developed a secret-police force called the Gestapo to eliminate opposition.

See also *Gestapo*; *KGB*; *Police state*.

Secretarial work includes a variety of activities that help keep an office running smoothly and efficiently. Secretaries may work in commercial, educational, governmental, industrial, or professional settings. They may assist one person or work for a number of people. Their duties may include maintaining office files and records, taking dictation, typing reports and correspondence, sorting mail, aiding visitors, answering telephones, and making travel arrangements. Many secretaries also schedule meetings and appointments and coordinate

office procedures. Some secretaries operate word processors and other electronic equipment.

The secretarial skills that employers seek vary widely according to the type of work. Women and men who wish to become secretaries should study such subjects as accounting, business administration, and office management, in addition to rapid note-taking, typing, and advanced keyboarding. Secretarial positions in such fields as law and medicine require specialized training in these areas.

Many people begin working as typists, word-processor operators, or receptionists. Typically, they advance to positions of secretary, executive secretary, administrative assistant, and administrative secretary. Some secretaries are later promoted to managerial positions.

Secretariat. See **United Nations**; **League of Nations**.

Secretariat. See **Horse racing** (Racing today).

Secretary bird is a tall African bird that has long feathers rising from the back of its head. The bird's name comes from these feathers, which suggest the quill pens secretaries and clerks once carried behind their ears. The secretary bird stands more than 1 metre tall, with long legs and a long tail. The bird is mostly grey with black feathers on its upper legs. Its eagle-like face is red to orange.

The secretary bird inhabits open grass plains and steppes in Africa south of the Sahara. It spends most of its time on the ground, walking with long, stiff strides. The bird hunts lizards, small mammals, large insects, snakes, and eggs of other birds. It sprints after prey and attacks with its feet and beak.

Secretary birds build nests on top of thorny acacia trees. The nests are made of sticks, leaves, and grass,

and measure 1 to 2 metres across. Females lay two or three greenish or bluish eggs. The young hatch from the eggs about 45 days later.

Scientific classification. The secretary bird belongs to the secretary bird family, Sagittariidae. It is *Sagittarius serpentarius*.

See also **Bird** (picture: Birds of Africa).

Secretion is a useful substance that is produced by and then discharged from a cell. Cells that form secretions are usually found in glands. Secretions from *exocrine glands* empty into *ducts* (tubes) that lead to other organs or to the surface of the body. Such secretions include saliva, tears, mucus, sweat, bile, and pancreatic juice. *Endocrine (ductless) glands* release their secretions directly into the blood. These secretions, called *hormones*, help regulate many body processes. Hormones include thyroxine, insulin, adrenaline, oestrogens, and androgens. Specialized cells in the intestines, the kidneys, the heart, and the placenta also secrete hormones. Plants and invertebrate animals also produce secretions, some of which have commercial value.

See also **Gland and Hormone** and their lists of *Related articles*; **Pearl**; **Resin**; **Silk**.

Secularism. See **Political science** (Secularism).

Securities. See **Investment**; **Bond**; **Stocks and shares**; **Unit trust**.

Security Council. See **United Nations** (The Security Council).

Security Service, generally known as *M15*, is the government service responsible for protecting Britain from espionage, sabotage, or any other activity dangerous to the state. The Security Service operates secretly and independently, but it often works in cooperation with government departments and with the Special Branch of the Metropolitan Police. The *Secret Service*, which is separate from the Security Service, directs secret agents working abroad for Britain. It is known as *M16*. Another body, the *Defence Intelligence Staff* of the Ministry of Defence, collects military information.

Sedan, Battle of. See **Franco-Prussian War** (Progress of the war).

Sedative is a drug that decreases the activity of the central nervous system. Sedatives are prescribed mainly to ease anxiety or to produce sleep. Their effect depends on the dosage. When taken in small amounts, the drugs calm a person. Slightly larger doses cause sleep. When used to produce sleep, the drugs are generally called *hypnotics*.

In the past, *barbiturates* were widely used as sedatives, but today they are rarely prescribed for this purpose. *Benzodiazepines* and a drug called *meprobamate* have sedative effects, but they are usually classified as anti-anxiety drugs. Since the early 1960's, anti-anxiety drugs have increasingly replaced sedatives in the treatment of anxiety (see *Tranquillizer*). Today, doctors prescribe sedatives mainly for insomnia and other sleep disorders.

Sedatives can be legally obtained only by prescription and should be taken only as directed. A person should not drive a motor vehicle or operate machinery after taking sedatives. Misuse of some of these drugs can lead to addiction. An overdose of sedatives can disrupt the brain's control of vital functions, such as breathing, and may be fatal.

See also **Barbiturate**; **Bromide**.



The secretary bird has long legs and a long tail. Narrow feathers extending from the back of its head resemble quill pens.

Sedge is one of a large family of grasslike plants that grow in wet places throughout the world. Sedges thrive in marshes, swamps, shallow water, and meadows. Like grasses, they have long, narrow leaves. But sedges usually have triangular or round, solid stems. Grasses have round, hollow stems. Sedges have three rows of leaves, but grasses have only two.

The *sheath* (covering) at the base of each sedge leaf is closed around the stem. In grasses, the side of the sheath opposite the leaf blade is split and overlaps.

Sedges have tiny green flowers on small spikes called *spikelets*. These flowers have no petals, but they have small bristles. Sedges also bear small fruits called *nutlets*. The ancient Egyptians made a writing material from a type of sedge called *papyrus* (see **Papyrus**). Today, farmers sometimes cut sedge for hay.

Scientific classification. Sedges make up the sedge family, Cyperaceae. The papyrus plant is *Cyperus papyrus*.

See also **Grass**; **Bulrush**.

Sedgefield (pop. 89,200) is a local government district in Durham, England. It was formerly a coal-mining area, but all the mines have been closed and manufacturing has taken their place. Local products include engineering and electrical goods. Towns in the district include Ferryhill, Newtown Aycliffe, Sedgefield, Shildon, and Spennymoor.

See also **Durham**.

Sedgemoor (pop. 97,000) is a local government district in northern Somerset, England, which attracts many tourists. The district's attractions include Cheddar Gorge, which has famous caves, and the seaside resort of Burnham-on-Sea. Bridgwater, the largest town in Sedgemoor, is a port and manufacturing centre. The Duke of Monmouth's rebellion ended in 1685 when the Duke was defeated at the Battle of Sedgemoor.

See also **Somerset**.

Sedges, John. See **Buck, Pearl S.**

Sedgman, Frank (1927-), was one of Australia's finest tennis players. From 1950 to 1952, he played 19 times for Australia in Davis Cup matches and lost only twice. In 1951, he became the first Australian to win the United States singles title. In 1952, he won the American, Italian, and Wimbledon singles titles. Francis Arthur Sedgman was born in Melbourne.

Sedimentary rock is rock formed when mineral matter or remains of plants and animals settle out of water or, less commonly, out of air or ice. Sedimentary rock covers about three-fourths of the earth's land area and most of the ocean floor. In some places, such as at the mouth of the Mississippi River, sedimentary rocks are more than 12,000 metres thick. Geologists estimate that sedimentary rock has been forming for at least $3\frac{1}{2}$ billion years. Sedimentary rock is one of three major kinds of rock. The others are igneous rock and metamorphic rock (see **Igneous rock**; **Metamorphic rock**).

There are many types of sedimentary rock and they have a variety of uses. The most common sedimentary rock is shale. It is made of compressed *mud*—that is, a mixture of clay and *silt* (fine particles of mineral matter). Shale is used in making bricks. Limestone, another common sedimentary rock, is made chiefly of the mineral calcite. Limestone is used for building, making chalk, and various other purposes. Cement is made of limestone with a little shale mixed in. Sandstone, made of

sand, and *conglomerate*, composed of sand or gravel particles, are also used for building. The sand or gravel particles in sandstone and conglomerate are held together by a mineral cement. Coal, consisting entirely of compressed plant remains, is a major source of fuel.

Most sedimentary rock starts forming when grains of clay, silt, or sand settle in river valleys or on the bottoms of lakes and oceans. Year after year, these minerals collect and form broad, flat layers called *beds* or *strata*. The layers, which differ from one another in composition or texture, distinguish sedimentary from most igneous and metamorphic rock. After thousands of years, the beds of fine silt and clay are squeezed into compact rock layers by the weight of other layers above them. Water that trickles slowly through layers of coarse sand and gravel, deposits mineral cement around these particles, cementing the layers together to form rock. Where the earth's crust is deformed or eroded, large areas of buried sedimentary rock may be exposed.

Some sedimentary rock forms during the evaporation of water. Thus, beds of rock salt were formed in bays cut off from the ocean or in saltwater lakes. The trapped water evaporated, leaving layers of salt crystals.

Most fossils are found in sedimentary rock. The fossils formed when sediments covered dead plants and animals. As the sediments changed to rock, either the remains or the outlines of the plants and animals were preserved. Some limestone is made entirely of fossil shells. See **Fossil**.

Related articles in World Book include:

Chalk
Clay
Coal
Coral
Flint
Limestone
Marl
Oil shale

Petroleum (How petroleum was formed)
Rock (pictures)
Sandstone
Shale
Stratified rock
Travertine

Sedition is an act which stirs up discontent against established government authority. Many countries have tried at times to prevent sedition by law. However, the right to criticize government officials and their actions is considered part of the freedom of speech guaranteed by many constitutions, so sedition laws are unpopular in peacetime. English common law created the offences of seditious libel and seditious words, which are the writing or speaking of words or sentences likely to encourage opposition to the government or constitution or incite disorder or violence.

In time of war, statements that are likely to hinder the successful progress of the war are dealt with as sedition. Sedition is regarded as a step toward treason. But it does not aim at direct, open violence.

See also **Treason**.

Sedum is a *genus* (group) of about 600 species plants that are decorative and hardy. Most sedums are



Sedums

native to the North Temperate Zone. They are *succulent* plants, or plants that store water in their thick, fleshy leaves (see **Succulent**). The flowers are star-shaped, yellow, pink and white, borne on usually flattened flower heads. Some sedums have low, creeping stems. Their leaves often grow in clusters near the ground. They are often used to cover rocks and bare ground. Others have tall stems and are used as border plants. They are also sometimes called *stonecrops*.

Scientific classification. Sedums belong to the orpine family, Crassulaceae. They are classified in the genus *Sedum*.

See, Holy. See **Pope** (introduction).

Seed is the specialized part of a plant that produces a new plant. It contains an *embryo* (partly developed plant) that consists of an immature root and stem. A seed also has a supply of stored food and a protective covering.

Seeds are produced by approximately 250,000 kinds of plants. The flowering plants make up the largest group of seed-producing plants. These plants, which botanists call *angiosperms*, include the vast majority of trees, shrubs, and soft-stemmed plants. Seeds are also produced by about 800 kinds of trees and shrubs called *gymnosperms*. Most gymnosperms develop cones.

The seeds of different kinds of plants vary greatly in size. The double coconut tree produces the largest seed, which weighs up to 23 kilograms. On the other hand, orchid seeds are so tiny that 800,000 of them weigh less than 30 grams. The size of a seed has no relationship to the size of the plant that develops from it. For example, the giant redwood tree grows from a seed that is only 1.5 millimetres long.

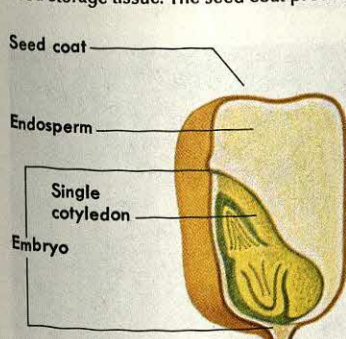
The number of seeds produced by an individual plant varies according to the size of the seeds. A coconut tree has only a few large seeds, but an orchid plant produces millions of tiny ones.

Kinds of seeds

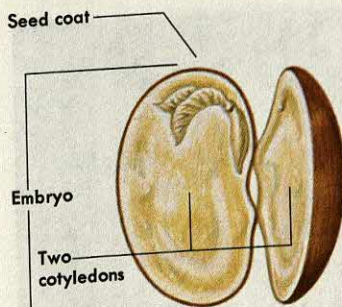
Seeds develop from structures called *ovules*, which are in the flowers or on the cones of a plant. Botanists divide seeds into two main groups, *enclosed seeds* and *naked seeds*.

The parts of a seed

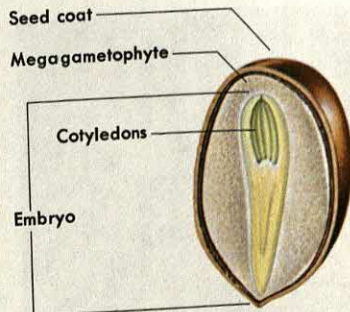
A seed consists of an embryo, food storage tissue, and a seed coat. The embryo contains the parts that form a new plant. It also has one or more *cotyledons*, which absorb and digest food from the food storage tissue. The seed coat protects the seed from injury, insects, and loss of water.



A monocotyledon seed, such as this maize seed, has one cotyledon. Its food storage tissue is called the *endosperm*.



A dicotyledon seed has two cotyledons. In the bean seed shown above, the cotyledons serve as the food storage tissue.



A gymnosperm seed, such as this pine seed, stores food in the *megagametophyte* and has two or more cotyledons.

Enclosed seeds are produced by angiosperms. Their ovules are enclosed by an *ovary*, a structure within the flower. As the seed ripens, the ovary enlarges and forms a fruit, which provides some protection for the developing seed. In some plants, the ovaries develop into fleshy fruits, such as apples and peaches. Other plants, such as peas and poppies, have dry fruits that form pods or capsules. In grain plants, such as barley, maize, rice, and wheat, the ovary and ovule join together, forming a hard kernel.

Naked seeds are produced by gymnosperms. These trees and shrubs produce ovules on the upper surface of the scales that form their cones. Gymnosperms have no ovaries, and so their seeds are not enclosed during development. However, the scales of the cones close up together when the seeds are ripening and provide some protection for the seeds.

The parts of a seed

Seeds consist of three parts: (1) the embryo, (2) the food storage tissue, and (3) the seed coat.

The embryo is the part of the seed from which the mature plant develops. It contains the parts that develop into the *primary root*, the first root to grow; the stem; and the first leaves of the new plant. The embryo also has one or more specialized leaflike structures called *cotyledons*. Angiosperms have either one or two cotyledons. Those with one cotyledon are called *monocotyledons* or *monocots*. Angiosperms with two cotyledons are called *dicotyledons* or *dicots*. Gymnosperms have from two to eight cotyledons.

The cotyledons absorb and digest food from the food storage tissue of the seed. In angiosperm seeds, this tissue is called the *endosperm*. The cotyledons of some dicotyledon seeds quickly absorb all the food in the endosperm. The cotyledons then store the food that the embryo needs for growth. In gymnosperm seeds, food is stored in tissue called the *megagametophyte*.

The seed coat covers the embryo and food storage tissue and protects them from injury, insects, and loss of water. Seed coats range from thin, delicate layers of tissue to thick, tough coverings.

How seeds develop

Seed formation results from sexual reproduction, in which a *sperm* (male sex cell) unites with an *egg* (female sex cell). The production of sperm and egg cells in seed plants involves a number of complicated steps. First, the male and female reproductive organs of the plant produce microscopic cells called *spores*. The spores grow into *gametophytes*, which are actually tiny plants that live within the reproductive organs of the parent plant. The gametophytes then produce the sperm and egg cells.

Seed development in angiosperms. The reproductive organs of an angiosperm are in its flowers. The female reproductive organ is called the *pistil*. The ovary, which contains one or more ovules, forms the round base of the pistil. A tube called the *style* extends up from the ovary and ends in a flat tip called a *stigma*. The male reproductive organ is called the *stamen*. The stamen has an enlarged tip called the *anther*.

The development of a seed begins with cell divisions in the ovule and in the anther. These cell divisions result in the production of spores. In most plants, one spore in each ovule grows into a microscopic female plant, the megagametophyte. This tiny female plant produces a single egg cell. In the anther, the spores grow into microscopic male plants called *microgametophytes*, or *pollen grains*. Each pollen grain produces two sperm cells.

For fertilization to occur, a pollen grain must be transferred from the anther to the pistil. This transfer is called *pollination*. Pollen grains are carried from the anther to the stigma by insects or other animals or by the wind. After the pollen reaches the stigma, the grain produces a long, slender *pollen tube*. This tube grows down through the style and into the ovule. The two sperm cells travel down the tube to the ovule. There, one sperm cell fertilizes the egg cell, and an embryo starts to form. The other sperm cell joins with two bodies called the *polar nuclei*, and the endosperm begins to develop. After fertilization, the outer layers of the ovule develop into the seed coat.

How seeds are spread

After seeds mature, they are usually scattered far from the parent plant. Seed dispersal occurs in various ways. Some kinds of seeds have fluffy coverings, *left*, that enable them to be carried by the wind. Fruits and seeds with spines or sticky coats can stick to people's clothing, *centre*, and be carried kilometres away. Animals disperse the seeds of brightly coloured berries, *right*. They eat the berries but do not digest the seeds, which are deposited as part of their body waste.

Seed development in gymnosperms. The reproductive organs of a gymnosperm are in its cones. A gymnosperm has two kinds of cones, *female seed cones* and *male pollen cones*. Each scale of a seed cone has two ovules on its upper surface. Cell divisions occur in the ovules, and each ovule produces a spore that grows into a megagametophyte. This tiny female plant produces egg cells. The scales of a pollen cone have structures that undergo cell divisions and produce spores. These spores develop into pollen grains.

The wind carries pollen grains from the pollen cones to the seed cones. The pollen gets stuck to a sticky substance near the ovules and begins to grow pollen tubes. Each pollen grain has two sperm cells. After the pollen reaches an ovule, one of the sperm cells fertilizes the egg cell, forming the embryo. The other sperm cell disintegrates. The megagametophyte becomes the food storage tissue of the seed. The seed coat develops from the outer layers of the ovule.

How seeds are spread

After seeds have matured, they go through a state of reduced activity called *dormancy*, when they do not sprout. During dormancy, seeds are *dispersed* (scattered) from the parent plant. Seed dispersal increases the chances that some of the seeds will fall in areas suitable for growth.

Some kinds of angiosperm seeds are dispersed while still inside the fruit. The fruit later splits apart or disintegrates and releases the seeds. In other types of flowering plants, the seeds are released from the fruit before dispersal.

Seeds are dispersed in various ways. In some cases, the fruit drops to the ground and the seeds sprout near the parent plant. However, most seeds have features that enable them to be carried long distances by the wind, animals, water, or people.

Many kinds of seeds are especially suited for dispersal by the wind. For example, gymnosperm seeds and some angiosperm fruits and seeds have winglike structures that keep them aloft. Such angiosperms include the fruits of maple trees and the seeds of ash and



elm trees. The wind also carries fruits and seeds that have fluffy coverings, such as dandelion fruits and cottonwood and willow seeds.

Animals also play an important role in seed dispersal. Birds and other animals eat brightly coloured fruits. However, the seeds are not digested. They are deposited as part of the animal's body waste—sometimes many kilometres from the parent plant. Animals also disperse seeds by carrying fruits and seeds on their body. The fruits of burdock and goosegrass, and many other plants have spines and barbs that stick to the fur of an animal. Seeds with sticky coats are also transported by sticking to an animal's body.

The seeds of most water plants are dispersed by floating on rivers, streams, ponds, and oceans. Palm trees, including coconut trees, and some other land plants have seeds that can float and are often transported great distances by water.

Some kinds of seeds are dispersed by an explosive action that occurs when the fruit dries and splits apart. The splitting of a fruit can scatter seeds over a wide area. The seeds of balsams and geraniums are dispersed in this way.

People have brought along supplies of the seeds of various crop plants and ornamental plants when migrating to many parts of the world. People also aid seed dispersal unintentionally by carrying seeds on their shoes and other articles of clothing.

How seeds sprout

Ripe seeds sprout through a process called *germination*. After being dispersed, most seeds remain dormant instead of germinating immediately. Dormancy prevents seeds from sprouting when conditions are not favourable for growth. For example, many seeds remain dormant during the cold winter months and germinate after temperatures start to rise in spring.

Seeds can remain dormant for varying periods of time and still be *viable*—that is, able to germinate under proper conditions. In general, the period of viability ranges from a few weeks to 50 years. In one case, however, scientists found that dormant 10,000-year-old lotus

seeds could germinate when conditions were favourable for growth.

Conditions required for seed germination include abundant water, an adequate supply of oxygen, and proper temperatures. When a seed begins to germinate, it absorbs large amounts of water. The water causes many chemical changes inside the seed. It also causes the seed's internal tissues to swell and break through the seed coat. Water also softens the seed coat so that it breaks apart more easily.

Germinating seeds require an adequate amount of oxygen to support their high rate of *respiration*. Respiration is the taking in of oxygen and the giving off of carbon dioxide. This process enables a germinating seed to burn food and produce the energy needed for growth.

Temperature requirements for germination vary. Species that germinate in summer require higher temperatures than those that germinate in spring. Many seeds require a cold period before they can germinate.

Some kinds of seeds also need light to germinate. Such seeds tend to sprout during the spring, when the number of daylight hours increases.

After the seed coat breaks and germination starts, the part of the embryo below the cotyledon begins to grow down into the soil. This part, called the *hypocotyl*, develops into the primary root. The developing roots anchor the seedling and absorb minerals and water that the embryo needs for further growth. The upper part of the embryo, called the *epicotyl*, has a bud called a *plumule* at its tip. The epicotyl grows longer and pushes the plumule upward above the ground. The plumule then produces the first leaves.

In the seeds of gymnosperms and certain dicots, the cotyledons are also carried above the ground. They remain on the plant until it has formed new leaves that can manufacture food. The cotyledons of monocots and some other dicots remain below the ground.

How people use seeds

Seeds serve as a major source of food for millions of people throughout the world. The seeds of cereal grains, including maize, oats, rice, and wheat, are used

How seeds sprout

Ripe seeds sprout through a process called *germination*. These photographs show the germination of a pine seedling. First, the lower part of the embryo breaks through the seed coat and begins to grow down into the soil, *left*. It develops into the primary root. Then the upper part of the embryo, which becomes the stem and leaves, pushes above the ground, *centre*. The cotyledons spread out, *right*, and remain on the plant until new leaves form.



in making many food products, such as bread, breakfast cereals, and flour. The seeds of plants called *legumes*, which include beans, peas, and peanuts, are also important sources of nourishment.

Vegetable oils used in cooking are obtained from the seeds of such plants as maize, peanuts, soybeans, and sunflowers. In addition, manufacturers use these oils in making margarine, salad oil, and shortening. Such flavourings and spices as dill, mustard, and pepper are obtained from seeds, and seeds are used in producing beer, coffee, cocoa, and other beverages.

Seeds are also used in the manufacture of many non-food products. Seed oils are a major ingredient in detergents, soaps, paints, and varnishes. Cornflour from the endosperm of the maize seed is used in making adhesives, explosives, and other products. Most livestock feed includes the seeds of maize, oats, and other grains. Some seeds, including those of the deadly nightshade and castor-oil plants, provide substances used in medicines.

Related articles in *World Book* include:

Angiosperm	Gymnosperm
Cotyledon	Monocotyledon
Dicotyledon	Nut
Flower (The role of flowers in reproduction)	Plant (Seeds; How plants reproduce; How plants grow)
Fruit	Pollen
Gardening (Starting the garden)	Spore
Germination	Tree (Seeds; pictures)
Grain	

Seeder. See **Drill**.

Seeger, Pete (1919-), is an American folk singer, musician, and composer. He first gained fame during the 1940's, singing about ordinary working people, war, and social problems. Seeger's musical style and concern with social issues influenced Joan Baez and many other folk singers. His best-known compositions include "Where Have All the Flowers Gone?" (1961).



Pete Seeger

Peter Seeger was born in New York City. He became interested in folk music at a folk music festival in 1935. He entered Harvard University in 1936 but left in 1938 to travel around the country, singing and painting. In 1940, he helped found a folk group called the Almanac Singers. He and Woody Guthrie, another noted folk singer and composer, sang with this group. Seeger sang with the Weavers, a folk quartet, from 1948 to the late 1950's, when he became a solo performer.

Seeing eye. See **Dog, Guide**.

Seferis, George. See **Greek literature** (Modern Greek literature).

Sefton (pop. 282,000), a local government district in Merseyside, England, includes the towns of Bootle, Crosby, and Southport. The southern part of Sefton includes docks on the Mersey. Bootle is the site of several government and private computer centres. The northern part of the district includes a rich agricultural area.



Girl Holding a Cat (1968); Mrs. Helen Segal Collection.

A typical **George Segal** sculpture is a realistic life-sized plaster cast of a human figure in everyday surroundings.

Segal, George (1924-), is an American sculptor who creates life-sized plaster figures in poses taken from everyday experiences. His sculptures realistically represent activities and moments normally taken for granted, such as stepping out of a shower, making a telephone call, or eating at a restaurant. He draws attention to these often-repeated daily activities by giving his works a fresh intensity through their isolation and lack of normal human association.

Segal makes his plaster casts from actual people, but the casts look anonymous and are meant to represent everyone. He usually paints the plaster white, but he also uses red and blue. In most works, the figures interact with real objects, such as doors, car steering wheels, and chairs, which are left in their normal form. Segal was born in New York City.

Segovia, Andrés (1893-1987), was the most influential classical guitarist of the 1900's. Segovia helped to establish the modern technique of guitar playing and was largely responsible for raising the guitar's status to that of a solo instrument in classical music.

Segovia's skill encouraged important composers to write for the guitar. Segovia also adapted works of many famous composers for the guitar and wrote some original pieces. He inspired generations of guitarists through his concert and television performances, recordings, and teachings.

Segovia was born in Linares, Spain. He began to teach himself to play the guitar when he was 12 years old. In

1909, Segovia gave his first public concert in Granada. By the early 1930's, he had gained international fame through concert tours of Europe, South America, and the United States.

Segrave, Sir Henry (1896-1930), was a British hero of the early days of motor racing. He broke the world land-speed record three times—in 1926, 1927, and 1929. He reached 231 miles (372 kilometres) an hour in 1929. Segrave was killed while raising the world water-speed record to 98.76 miles (158.94 kilometres) an hour. The Segrave Trophy, given to the Briton who best showed the possibilities of transport by land, air, or water, was named after him. He was born in Edmonton.

Segregation is the separation of groups of people by custom or by law. It is often based on differences of ethnic origin, religion, wealth, or culture. Some people consider such differences highly important.

Segregation can occur in almost any area of life. It is particularly evident in housing, education, and employment, and in the use of eating, sleeping, transportation, and other public facilities. Almost all systems of segregation discourage marriage between people of different racial, religious, or social groups. In the United States, for example, many states outlawed marriage between blacks and whites. But in 1967, the Supreme Court of the United States ruled such laws unconstitutional. Segregation almost always involves some kind of discrimination by one group against another. The term *discrimination* refers to actions or practices by members of a dominant group that limit the opportunities of a less powerful group.

The term *desegregation* refers to the process of ending group separation. During the course of desegregation, two or more separated groups may begin to act toward each other in new, friendlier ways. This new relationship between the groups is called *integration*.

Causes and effects of segregation

Segregation is usually the result of a long period of group conflict, with one group having more power and influence than another group. The *dominant* (more powerful) group sometimes uses force, law, or custom to segregate a *subordinate* (less powerful) group. In time, segregation comes to be considered right, especially by the dominant group. Violations of the accepted code of segregation are considered wrong. People who break the code are believed to deserve stern punishment.

Further support for segregation comes from hostile attitudes and feelings between groups. The dominant group typically believes its members are born with superior intelligence, talents, and moral standards. Social scientists call these false or exaggerated beliefs *stereotypes*. The dominant group uses stereotypes to justify its mistreatment of the subordinate group. Meanwhile, the subordinate group develops fear and dislike toward the dominant group.

Segregation involves favoured treatment for the dominant group. Members of this group are expected to have—and usually do have—the best education, homes, jobs, and public services. As a result, their beliefs of superiority are strengthened. They do not consider the system unfair but regard it as the proper way for society to distribute its resources. Likewise, the subordinate group may have a sense of inferiority that is reinforced

by a system that denies it the social, political, and economic benefits enjoyed by others.

Examples of segregation

In the United States, segregation of ethnic groups in its modern form started in the late 1800's. But slavery existed for more than 200 years before the Civil War (1861-1865). After the war, the freed blacks suffered widespread discrimination, especially in the South.

Jim Crow laws, first developed in a few Northern states in the early 1800's, were adopted by many Southern states in the late 1800's. These segregation laws required that whites and blacks use separate public facilities. No detail was too small. At one time, for example, Oklahoma required that whites and blacks use separate telephone booths. Such *de jure* (by law) ethnic segregation in America was strengthened by several decisions of the Supreme Court.

Starting in the 1930's, blacks have gained increasing prominence in national politics and a fairer hearing in federal courts. In 1954, the Supreme Court ruled against *de jure* segregation in state schools.

In the 1960's, attention shifted to *de facto* segregation—that is, segregation in fact. This type of separation has developed more by custom than by law. Although many laws that support *de jure* segregation were declared unconstitutional, *de facto* ethnic segregation increased during the mid-1900's.

In American cities, blacks were as segregated in housing in the 1980's as they were in the 1930's.

De facto segregation was a basic cause of the *race riots* that swept American cities in the 1960's and early 1980's. The riots represented, among other things, a mixture of desperation and defiance.

Segregation has existed for many centuries. During the Middle Ages, from the 400's to the 1500's, segregation was especially directed against European Jews. In many countries, Jews had to live in city ghettos. Laws prohibited them from owning land, joining labour guilds, or practising medicine or law. As a result, these Jews could earn a living only in occupations avoided by Christians, including moneylending and tax collecting. In time, people came to think of Jews as a group that dealt dishonestly in trade. Jews were falsely blamed for all types of misfortunes, even the plagues which swept Europe during the Middle Ages.

Segregation also can occur along religious lines, with sacred approval. An example is the complex Hindu system of separation by *castes* (social classes created by ancient religious laws) in India. For about 2,000 years, the many castes remained strictly separated in almost all areas of life. In 1948, the Indian government began a campaign against the caste system. Progress has been made, but segregation remains in many parts of India. See *India* (Religion).

In most countries, segregation and discrimination are based on national and ethnic differences. For example, Koreans living in Japan are typically segregated, discriminated against, and regarded as inferiors by the Japanese. For many years, South Africa had the world's most complete system of ethnic segregation. The South African government, controlled by whites, followed a policy called *apartheid*, which aimed to subordinate black Africans in every walk of life (see *Apartheid*).

Since the early 1940's, segregation has declined steadily in many parts of the world. Several forces have led to increased contact across class, cultural, ethnic, religious, and national lines. These forces include the end of colonialism, the expansion of literacy, the rapid growth of cities, and protest movements by subordinated peoples. Other forces have been mass migrations and the growth of rapid transportation systems and of mass communication.

Related articles in *World Book* include:

Apartheid	Jews
Caste	Minority group
Civil rights	Racism
Indian, American	South Africa

Seiche is a long wave in a lake, a bay, or some similar basin. Seiches are usually caused by high winds, small earthquakes, or changes in atmospheric pressure. Minor seiches occur frequently on Lake Geneva in Switzerland and on Lake Erie and the Great Salt Lake in North America.

A seiche is a *standing wave*—that is, there is no forward motion of the water as the seiche moves through it. Instead, the motion of a seiche resembles that of a bowl of water that has been tilted and then set right. The water moves only up and down. A seiche has a wavelength equal to twice the length of the body of water on which it occurs.

Seidler, Harry (1923–), an Australian architect, designed some of Sydney's best-known tall buildings. Among these buildings are Australia Square, MLC Centre, and Grosvenor Place. Seidler's work overseas includes the Australian Embassy in Paris and the Hong Kong Club and Tower.

Seidler was born in Vienna, Austria. He studied architecture under Walter Gropius at Harvard University, in the United States. He started a practice in Sydney in 1948. That same year, he designed his first house. This house, which was for his parents, is in Clissold Street, Turramurra. It is now known as the *Rose Seidler House*. It was made into a museum in 1986.

Seigneurial system, also spelled *seigniorial*, was the traditional method of landholding in France. It came into use in colonies that France established in eastern Canada during the early 1600's and lasted about 250 years. The system did much to strengthen the growth of French culture in Canada.

The king of France granted large areas of land in Canada to nobles, religious groups, military officers, and merchants. These grants, which were called *seigneuries*, generally covered from 31 to 260 square kilometres. Many of them bordered the St. Lawrence River and extended inland in narrow strips. The owners, who were called *seigneurs*, rented sections of their land to farmers. Each year, the farmers, known as *habitants* or *censitaires*, gave the seigneurs a share of the harvest, a fee, and several days' work without pay. Habitants and seigneurs in turn owed the king military service and helped build public roads.

The number of habitants in Canada increased during the 1700's, and the seigneurs earned large profits. But many of the holdings limited urban and industrial growth during the early 1800's. The Canadian government abolished the system in 1854.

Seine. See **Fishing industry** (Nets).

Seine River and its branches form the chief commercial waterway of France. It rises 29 kilometres northwest of Dijon. From there, the Seine flows in a winding course about 764 kilometres northwest to its mouth in the English Channel near Le Havre. About 378 kilometres from its source, it becomes the broad river that flows through the heart of Paris. In Paris, it moves under more than 30 bridges, some of which are over 300 years old. The Cathedral of Notre Dame stands on the *Île de la Cité* (Island of the City) in the Seine.

Boats on the Seine carry sightseers through Paris. Boats also carry people and goods westward from Paris on the Seine past St.-Cloud, famous for its horse races, and past St.-Germain with its handsome palaces. The Seine then winds through the province of Normandy to Rouen and the seaport of Le Havre. Southeast of Paris, the river flows near Fontainebleau.

The Seine is joined by the Aube, Marne, Yonne, and Oise rivers. Canals connect the Seine with the Loire, Rhône, Rhine, Meuse, and Schelde rivers. Boats can sail about 547 kilometres of its length. The Seine has flooded its banks many times. It caused extensive damage when it rose more than 7 metres during a flood in 1910. **Seismograph** is an instrument that amplifies and records small movements of the ground. From these records, scientists called *seismologists* can determine the location and intensity of earthquakes. Scientists also use seismographs to hunt for oil, study the earth's interior, and find the thickness of glaciers.

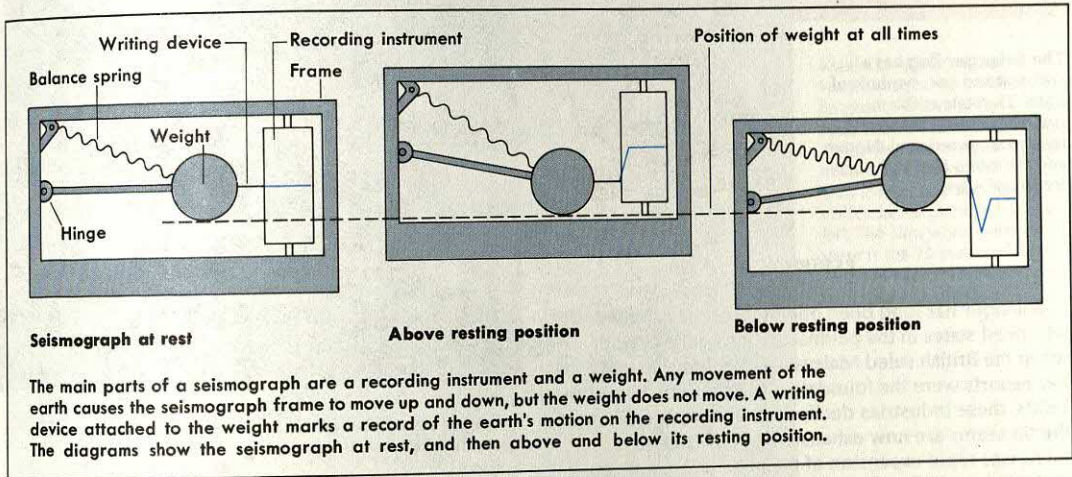
The most sensitive seismographs magnify ground motion by as much as ten million times. They consist of a weight suspended from a frame by a delicate spring. The frame moves with the ground. But the weight, due to its inertia, tends to remain stationary (see **Inertia**). The relative motion between the weight and the frame is magnified by using an electromagnetic transducer and an electronic amplifier. The transducer, a coil attached to the weight, moves in the magnetic field created by a magnet attached to the frame. This movement induces a voltage in the coil which passes to the amplifier. The amplified voltage is recorded by a computer or by a device that marks the ground motion on a moving sheet of paper. Some seismographs can detect ground motion as small as one tenth of a nanometre. A nanometre equals one billionth of a metre. A station in a quiet location may detect several earthquakes every day.

Different types of seismographs are used to measure short and long seismic waves. The *Press-Ewing* seismograph records long waves at least 800 kilometres in length. The *Benioff linear strain* seismograph measures changes in distance between two piers attached to the ground. The *strong motion accelerograph* records shaking that is too strong for sensitive instruments. Seismographs are used in groups of three to measure separately three types of ground motion: up-down, north-south, and east-west. There are more than 1,000 seismograph stations throughout the world.

The seismographs used for scientific studies and prospecting are tiny and rugged. Scientists place hundreds of them around the site being studied. Then, the scientists set off explosives to create seismic waves, which travel to underground rock layers and are reflected. The seismographs measure the reflected waves and indicate what lies beneath the surface.

How a seismograph works

A seismograph draws a wavy line, *right*, to show the motion of the earth during an earthquake. The simplified diagrams below show how the instrument records this motion.



Astronauts placed five special seismographs on the moon. The seismographs detected seismic waves caused by tiny moonquakes and by meteorite impacts.

See also **Earthquake**; **Petroleum** (Geophysical studies); **Richter magnitude**; **Seismology**.

Seismology is the study of *seismic waves* (shock waves) produced by earthquakes or explosions. *Seismologists* study these waves to learn about earthquakes and about the structure of the earth. Seismology forms a branch of *geophysics*, the science that applies physics to the study of the earth and its atmosphere.

Instruments called *seismographs* detect and record the movement of seismic waves (see **Seismograph**). Seismologists use these records to determine the location and strength of earthquakes. They seek ways to predict and possibly even control future earthquakes (see **Earthquake**). Scientists also use seismographs in exploring for minerals and petroleum.

There are several kinds of seismic waves, including *compressional waves* and *shear waves*. Compressional waves travel through solids and liquids, but shear waves pass only through solids. The speed of a seismic wave varies as the wave travels through different kinds of rock. The study of seismic waves has shown that the earth consists of layers of various substances. Seismologists believe the earth's outer core is a liquid consisting mainly of iron because shear waves do not pass through this layer. Seismographs placed on the moon indicated that the moon has a thick, strong crust.

Seismologists use various methods to gain information about the rock layers in the earth's crust. In the *reflection technique*, for example, sound waves are bounced off underground rock layers. As the waves are reflected back to the surface, sensitive instruments record their travel time. This technique is often used to locate rocks that might contain gas or oil.

Seismology has provided evidence that supports the *plate tectonics theory*. According to this theory, the earth's outer shell consists of about 30 rigid plates that

are in continual motion. The collision, separation, and sliding of the plates creates *island arcs* (volcanic islands), mountains, volcanoes, and oceanic ridges and trenches. Plate movements also cause earthquakes, most of the major ones occurring along the edges of the plates. See **Plate tectonics**; **Continental drift**.

See also **Richter magnitude**.

Seismometer. See **Seismograph**; **Space exploration** (Other moon landings).

Sekoto, Gerard (1913-1993), a South African artist, first achieved recognition in the 1940's for his vivid, colourful paintings of township life. Gerard was regarded as a pioneer in modern South African art. His work continues to influence younger generations of artists.

Sekoto was born at Botshabelo, Transvaal. He trained as a teacher at Grace Dieu, a college near Pietersburg, Transvaal. In 1938, Sekoto moved to Johannesburg, where he gained recognition from fellow artists. Sekoto moved to Cape Town in 1942 but later emigrated to Paris, where he lived in self-imposed exile from 1947 until his death.

See also **South Africa**, **Art of**.

Selangor is a state on the west coast of Peninsular Malaysia. Perak forms the boundary to the north, Pahang to the east, Negeri Sembilan to the south, and the Strait of Malacca to the west. The Malaysian federal capital, Kuala Lumpur, lies within Selangor's boundaries, but is governed separately. See **Kuala Lumpur**.

People and government

More than 44 per cent of the population of Selangor are Malay. About 37 per cent are Chinese, and 17 per cent are Indian. Most of the population live around Kuala Lumpur. Expanding industry has led to the building of satellite towns, such as Petaling Jaya, from which many people commute to work in the federal capital. The head of state of Selangor is a *sultan*. The state legislative assembly has 42 seats.

See also **Malaysia**, **Government of**.



The Selangor flag has a crescent and star, symbols of Islam. The state emblem, right, has state symbols of a red spear, sword, and dagger, and the motto *Under the protection of Allah*.



Economy

Selangor has long been one of the most economically advanced states in the peninsula. During the period when the British ruled Malaysia as a colony, tin and rubber exports were the foundation of its wealth. Since the 1960's, these industries declined in importance. Many of the tin seams are now exhausted. In the same period, there was rapid expansion of manufacturing, much of it in the Kelang Valley, between Port Kelang and Kuala Lumpur. Heavy industry includes a major steel-producing plant, but there is also a strong emphasis on high technology production. The Malaysian car, the Proton Saga, is manufactured near the state capital of Shah Alam. There is also a large number of food processing plants.

The state has excellent communications, mainly because the federal capital, Kuala Lumpur, lies within its borders. The main west coast railway runs from north to south through Selangor. The state is also at the centre of the peninsula's road network, with major roads running from Kuala Lumpur to the north and south, and to the east coast. The main international port in the peninsula is at Port Kelang, and Malaysia's principal international airport is at Subang.

Land

The Main Range of mountains forms the state's border with Pahang to the east. The Main Range is heavily forested. The Selangor, Langat, Kelang, and Bernam rivers rise in the region and flow westward through the state to the Strait of Malacca (Melaka). From the Main Range, Selangor stretches westward over limestone and sandstone foothills, which have substantial deposits of tin. West of the foothills is a low-lying plain that runs without break along the coast. The plain consists of silt and rock debris deposited by the rivers from the Main Range. Mangrove forests line the coastal margins of the plain. Behind the mangrove belt, there is much agricul-

Facts in brief about Selangor

Population: 1991 census — 2,289,236.

Area: 7,956 km².

State capital: Shah Alam.

Largest cities: Shah Alam, Kelang, Petaling Jaya.

Chief products: *Agriculture*—cocoa, coconuts, coffee, palm oil, rice, tin. *Manufacturing*—electronic products, household appliances, processed food, steel, vehicles.



Selangor state mosque is a striking modern building in the newly developed state capital of Shah Alam.

tural land, but large areas of swamp and lowland rain-forest remain.

History

Human settlement in the Kelang River valley dates from *neolithic* times (see **Stone Age**). During the 1300's, Kelang and the surrounding coastal area formed part of the great Javanese empire of Majapahit (see **Majapahit**). In the 1400's, it came under the control of Melaka, to the south. In 1511, Melaka fell to the Portuguese, and the Kelang rulers gained greater independence. But the huge tin resources of their lands attracted many foreign traders. The Dutch, having taken Melaka from the Portuguese in 1641, attempted to control the local tin trade by building forts at Kuala Linggi and Kuala Selangor. At the same time, Bugis traders pushed aside the original Minangkabau settlers. By the mid-1700's, the Bugis had established the present sultanate, with the capital at Kuala Selangor, and were successfully resisting Dutch power.

The rapid expansion of international demand for tin from the mid-1800's transformed the economy of Se-



Selangor is a state on the west coast of Peninsular Malaysia. Kuala Lumpur, the federal capital, lies within it.



Kuala Lumpur, Malaysia's federal capital, lies within Selangor, so the state has good road and rail communications. The main railway station, built in an ornate Moorish style with towers and cupolas, is visible in the picture, *bottom left*. The slim white pillar beyond is the 73-metre minaret of the modernistic Masjid Negara (national mosque).

langor. Thousands of Chinese miners arrived to extract tin. Wealthy Chinese tin miners and the Malay rulers became involved in fierce conflicts for control of the main deposits. By the 1860's, the state was sliding towards anarchy and civil war, and the trade in tin decreased dramatically. In the mid-1870's, the British administration in the Straits Settlements intervened to restore order. In August 1874, they appointed an official *resident* (government representative) to Selangor. The sultan remained head of state, the *indigenous* (local) peoples remained his subjects, but the British ruled. In 1896, the British completed a scheme to combine Selangor with Perak, Negeri Sembilan, and Pahang, forming the Federated Malay States (FMS), with the federal capital at Kuala Lumpur. This measure further weakened the political position of the Malay rulers.

Places to visit

Following are brief descriptions of some of the interesting places to visit in Selangor:

Batu Caves are a series of natural limestone caves of great size and depth. The white-roofed Cathedral Cave contains an image of the Hindu god, Lord Subramaniam. During the festival of Thaipusam, thousands of Hindu devotees climb the 272 steep steps up to the shrine.

Genting Highlands, shared with Pahang, offer cool mountain air and extensive recreation and amusement facilities.

Kelang is the most important historic town in the state.

Mimaland (Miniature Malaysia Land) provides varied recreational facilities in a jungle setting, including the largest outdoor swimming pool in Southeast Asia.

Shah Alam contains the state mosque, which has a blue dome overlaid with steel latticework. Bukit Cahaya Seri Alam is a large agricultural park in a jungle setting.

Templer Park contains a mass of limestone formations. The park provides opportunities for hiking, camping, and swimming. It contains an impressive collection of flowering and nonflowering plants, some of which are unique to Malaysia. It also has many types of birds and butterflies.

At the same time, the economy of Selangor grew substantially. Tin production expanded most rapidly in the late 1800's. In the early 1900's, the new export commodity of rubber began to rival tin in importance. Huge European-owned rubber plantations in Selangor employed large numbers of Indian labourers, recruited from south India. The plantations were mainly in the area between the foothills and the coast. Many immigrants also came from the Dutch East Indies (now Indonesia) to cultivate coconuts, fruit, rice, and spices.

At the beginning of the 1900's, Selangor was the most advanced of the Malay states under British administration. It possessed an excellent network of roads, railways, and ports and a rapidly growing population.

In 1948, Selangor became part of the Federation of Malaya. On Aug. 31, 1957, the Federation of Malaya became independent from British rule. Since the 1960's, the economy of Selangor has continued to run in advance of that of the other states in the peninsula. Selangor now has a substantial manufacturing base and a highly developed modern service sector. But the state has also seen more acute ethnic tension than anywhere else in the peninsula. During the Chinese-Malay riots of May 1969, the violence was worst in Selangor.

See also **Malaysia**; **Malaysia, History of**.

Selassie, Haile. See **Haile Selassie I**.

Selby (pop. 88,300) is a local government district centred on the town of Selby in North Yorkshire, England. Selby is crossed by the River Ouse and has a small port at Selby town. The district has some of Britain's finest agricultural land. Other important industries are shipbuilding and brewing. During the 1980's, a huge new coal mine was developed near Selby. The University of York is in the east of the district. See also **Yorkshire**.

Selection acts were a series of acts in Australia which sought to lessen the monopoly of the squatters, who held large areas of land. The acts also sought to allow

new settlers, who wanted small farms, to obtain some land. In New South Wales, the Robertson Act of 1861—the Crown Lands Alienation Act—provided for free selection before survey. It permitted a person to buy 40 to 320 acres (16 to 128 hectares) at 1 British pound an acre at a deposit of 25 per cent. The remainder was to be paid over three years. The selector was expected to reside on the land and make improvements. Similar acts in Victoria included the Nicholson Act (1860), the Duffy Act (1862), and the Grant Act (1865). The main features of these acts were selection after survey, compulsory residence, and necessary improvements. In Queensland, the Macalister Act (1868) was designed to break the monopoly of the squatters. By surrendering one half of their land, squatters could obtain a lease for the remainder for another 10 years.

In South Australia, the Strangways Act (1867) and the Waste Lands Act (1872) opened the way for free selection by credit purchasers. In Western Australia, an Act of 1872 restricted selection to 40 acres.

Some of the big squatters employed *dummies*—people who agreed to select land and then make it over to squatters. Other squatters used the names of children of minor age to gain selection. Some took out mineral leases over nonmineral country for nominal fees. The abuses of the acts were probably greatest in New South Wales. By 1883, more than half of the selections in that state belonged to capitalists or squatters. In 1884, a new act greatly reduced these abuses of the system.

Selene was the principal goddess of the moon in Greek mythology. The Roman goddess Luna resembled her. Helios, the sun, was Selene's brother. Every day, he drove his fiery chariot across the sky. At night, after his return, Selene drove her own chariot across the sky. The rays from her golden crown lit up the night.

Selene played an important part in ancient magic rituals, but she appears in few myths. The best-known story about Selene tells of her love for Endymion, a handsome mortal. Either Selene or Zeus, the king of the gods, caused Endymion to fall into an eternal sleep. Myths differ on why Endymion was put to sleep.

Some ancient sources say Selene was the daughter of Hyperion and Theia. Others say she was the child of Zeus and Leto. Many ancient Greek writers confused Selene with the goddess Artemis. As a result, some myths incorrectly identify Artemis, rather than Selene, as the moon goddess.

See also **Artemis**; **Endymion**; **Luna**.

Selenium is a chemical element with the symbol Se. It is a semimetal. In nature, it most often occurs in combination with such metals as copper, lead, and silver. The Swedish chemist Jöns J. Berzelius first isolated selenium in 1817.

Human beings and other animals require tiny amounts of selenium in their diet. The element plays a role in the body's ability to convert fats and protein into energy. Foods that supply selenium include meat and fish.

Selenium exists in several forms called *allotropes*. The most stable allotrope is grey selenium, a solid that forms when the element is heated to 180° C and cooled. Grey selenium is a semiconductor and becomes a better conductor of electricity when exposed to light and heat. It is used to make electric eyes, solar batteries, and pho-

tographic exposure meters. It also is used in photocopying machines.

The atomic number of selenium is 34, and its atomic weight is 78.96. Grey selenium melts at 217° C and boils at 685° C.

Seleucid dynasty refers to a series of kings who ruled in southwest Asia from 312 to 64 B.C. Seleucus I, a Macedonian general, had served under the Macedonian conqueror Alexander the Great. By 323 B.C., when Alexander died, he controlled much of southwest Asia. Seleucus established an empire from part of this area. At its height, the Seleucid Empire extended from Asia Minor (now Turkey) eastward to India. The Seleucids established many cities and promoted the spread of Greek customs and religious beliefs.

During the 200's B.C., the Parthians took over the far eastern region of the empire. In 188 B.C., the Romans forced the Seleucid king Antiochus III to give up much of Asia Minor. Later during the 100's B.C., the Seleucids lost control of Palestine to the Jews and Mesopotamia to the Parthians. Syria, the last Seleucid territory, fell to the Romans in 64 B.C.

See also **Judah Maccabee**; **Syria** (History).

Self-defence. See **Martial arts**; **Judo**; **Karate**.

Self-government. See **Government**; **Home rule**.

Seljuks were members of a ruling family of Turkic-speaking peoples who controlled much of southwestern Asia from the mid-1000's to the mid-1200's. They originated in an area of central Asia called Turkestan and were named after Seljuk, their first leader. The Seljuks also became one of the first Turkish peoples to rule in Asia Minor (now Turkey).

In 1055, Seljuk forces conquered part of the Arab Empire in southwestern Asia. In 1071, Seljuk armies defeated Byzantine forces in the Battle of Manzikert. This victory enabled them to eventually win control of Asia Minor. By the end of the 1000's, the Seljuks had gained control of Persia (now Iran), Syria, and Palestine. Like most of the people in these areas, the Seljuks were *Muslims* (followers of Islam). The Seljuks defended Islamic civilization during the *Crusades*, which began in 1096. These were military expeditions led by European Christians who wanted to drive the Turks out of Palestine (see *Crusades*). Much of the Seljuk Empire declined during the 1100's. But the Seljuk branch in Asia Minor flourished until the 1240's, when Mongol invaders weakened its rule. This branch laid a foundation for the rise of the Ottoman Turks in the 1300's.

See also **Muslims** (The Seljuk Turks); **Palestine** (Arab control); **Turkey** (The Seljuk Turks).

Selkirk, Alexander (1676-1721), was a Scotsman whose experiences as a castaway on a lonely island inspired the story of Robinson Crusoe (see **Robinson Crusoe**). While sailing in the South Seas in 1704 on a pirate expedition, Selkirk quarrelled with the ship's captain. At his own request, he was left on one of the Juan Fernández islands, about 640 kilometres west of Valparaíso, Chile. He lived alone for 52 months, until Captain Woodes Rogers rescued him. The captain recorded Selkirk's experiences on the island in *A Cruising Voyage Around the World*. Captain Edward Cooke described them in *A Voyage to the South Seas and Round the World*. Selkirk was born in Largo, Fifeshire.

See also **Juan Fernández**.

Selkirk, Earl of (1771-1820), a Scottish colonizer, opened the Canadian West for settlement during the early 1800's. He founded the Red River Colony, the first settlement in what is now Manitoba (see **Manitoba**).

Selkirk, whose original name was Thomas Douglas, was born on St. Mary's Isle in Kirkcudbrightshire (now Dumfries and Galloway Region), Scotland. He became the fifth Earl of Selkirk in 1799.

In 1803 and 1804, Selkirk sent about 900 Scottish peasants to settle in the Canadian colonies of Prince Edward Island and Upper Canada. He established the Red River Colony in 1812 with about 100 people. But the farming colony interfered with the local fur trade. In 1815, trappers of the North West Company, a fur-trading firm, and a group of *métis* (people of mixed white and Indian ancestry) drove out the settlers. Troops led by Selkirk regained control in 1817.

Selkirkshire. See **Borders Region**.

Sellers, Peter (1925-1980), was a versatile British actor. Films in which he appeared include *The Ladykillers*; *I'm All Right, Jack*; *The Millionairess*; *Only Two Can Play*; *Lolita*; *The Pink Panther*; *Dr. Strangelove*; *Alice's Adventures in Wonderland*; and *Being There*. Sellers was born at Southsea, Hampshire. He began his career at the Windmill Theatre in London, but achieved his first real success on such radio and television programmes as *The Goon Show* (with Spike Milligan and Harry Secombe) and *A Show Called Fred*. He won the British Film Academy Award for 1959 for *I'm All Right, Jack*.

Selling. See **Salesmanship**.

Selva. See **Tropical rainforest**; **Peru** (The selva).

Selvon, Samuel (1923-), a Caribbean writer, became known for his tragicomic depiction of the poor and outcast in Trinidad and the United Kingdom. His work explores the lives of those who left the Caribbean for a brighter future in the United Kingdom, only to face prejudice, isolation, and exploitation.

Samuel Dickson Selvon was born in Trinidad and educated at Naparima College. During World War II (1939-1945), he served as a wireless operator in the Trinidad Royal Naval Volunteer Reserve. He later worked as a journalist on the *Trinidad Guardian*. By the time Selvon moved to England in 1950, he had already established a reputation as a poet and short story writer.

His first novel, *A Brighter Sun* (1952), is set in Trinidad and features the character of Tiger, an East Indian peasant. The novel shows the struggle of various ethnic groups to establish a single Caribbean identity. It is praised as the first work of West Indian fiction to use dialect as the language of consciousness. *The Lonely Londoners* (1956) is a foremost novel about exile. Through the character of Moses, Selvon explores the loneliness and rejection experienced by the West Indian community in London during the 1950's.

Selwyn Range is a series of low mountains in Queensland, Australia. It divides the rivers that flow into the Gulf of Carpentaria from those of the central drainage basin.

Selye, Hans (1907-1982), was a Canadian scientist who became known for his concept of strains on the body known as *stress*. His study of endocrine glands helped him develop new understandings of the nature and effects of disease and the body's reactions to problems or events in a person's life. His medical research showed

what can be done to adjust the body to many types of unpleasant conditions. Selye was born in Vienna, Austria. He spent most of his professional career at the University of Montreal in Canada. In 1976, he founded the International Institute of Stress.

Semantics, in logic, is the study of the conditions under which signs and symbols, including words, may be said to be meaningful. It is also the study of how human behaviour is affected by words, whether spoken by others or to oneself in thought. In philology, the scientific study of languages, semantics used to mean the historical study of changes in the meanings of words.

Semantics may be said to ask such basic questions as: "What are you talking about—if anything?" and "What are the relations between words and the things talked about?" Semantics deals with meaning as a factor in all human relations. Human beings are the only creatures who can talk themselves into trouble, and semantics is concerned with how to avoid doing so.

Modern semantics originated in the early 1900's in what an English philosopher, Lady Viola Welby, called *significs*. She described it as "the science of meaning or the study of significance, provided sufficient recognition is given to its practical aspect as a method of mind." Lady Welby felt that a proper study of meaning should begin with the study of experience.

C. K. Ogden, a British psychologist, and I. A. Richards, an English literary critic, contributed insights from psychology, anthropology, and the physical sciences. They showed how emotive utterances are often mistaken for statements of fact; how meaning is determined by context; and how disputes are caused by lack of awareness of verbal traps.

The *operationalism* of P. W. Bridgman, an American physicist, added much to semantics. According to Bridgman's theory, a statement may be said to have meaning only if it can be translated into operations to test it. If a table is said to be 16 metres long, a person can measure it with a ruler. But if one says "Man is born free, but everywhere he is in chains!" what operations could verify this assertion?

Alfred Korzybski, a Polish-American scientist, proposed a system called "general semantics." The basic postulates state that (1) words are not to be confused with things; (2) words can never say all about anything; and (3) words about words about words, and so on, can go on indefinitely.

See also **Dictionary**; **Linguistics** (The components of a grammar); **Richards, I. A.**

Semaphore is a method of signalling with targets or flags. Each target position has a meaning that trained persons can interpret. A standard set of flag directions spells out the English alphabet. Each of these is shown in an alphabet letter article in *World Book*, such as **A**. A sequence of these directions can be used to spell out words in a message. Numerals are spelled out, but some directions represent words, such as "error", or phrases. There may also be slight variations in the direction for **A** and **G**.

Semaphore flags are used by the world's navies and the railways. Messages can be sent at a speed of approximately 25 words a minute.

See also **Flag** (picture: Semaphore flags); **Railway** (Traffic control).

Semarang (pop. 1,026,671) is the capital and largest city of the province of Central Java. It is the fifth biggest city in Indonesia. Semarang is Central Java's main port.

The city. Semarang stands near the northern coast of Central Java. For location see **Indonesia** (political map). The city occupies the narrow coastal plain between the Java Sea and Mount Ungaran. About half of Semarang lies on a swampy region near the harbour. The rest stands on the foothills of Mount Ungaran to the south. The area around the harbour is extremely hot and humid. It sometimes records the highest temperature in the whole of Indonesia. Candi, the southern part of the city, receives cooling breezes from the Java Sea, and has a more temperate climate. Semarang receives an average of about 165 centimetres of rain a year.

When strong monsoon winds blow, Semarang's harbour can be dangerous. In the past, it provided little protection for ships. There was substantial development at the harbour during the 1980's. A 5,100-metre-long breakwater, completed in 1985, enabled the port to operate all year round. Tanjung Mas, the port at Semarang, is now the fifth largest Indonesian port in terms of goods handled. The port now provides facilities for oceangoing ships of up to 10,000 metric tons.

Semarang's main residential suburb is Candi. It has many beautiful houses and bungalows built along winding streets that follow the pattern of the hills. The view from Candi takes in the lower part of the city and the Java Sea. To the west of Candi is *Candi Baru* (New Candi), a modern residential suburb.

Places of interest include Taman Hiburan Rakyat where there is a unique snake park. There are also many interesting Hindu-Javanese temples in the districts around Semarang. The most popular tourist attractions are the Chinatown district, and the Sam Po Kong temple near the airport. Local Chinese believe the temple to be the burial place of Cheng Ho, an admiral in the Imperial Chinese Navy during the 1400's.

People. The province of Central Java is one of the most densely populated parts of Indonesia. The Indonesian government has moved many people to other parts of Indonesia to ease the pressure of population in Central Java. Semarang is a major centre through which people pass before resettling in southern Sumatra, Kalimantan, or Irian Jaya.

Semarang is mainly a trade and industrial centre. The State University of Diponegoro opened in 1960. But unlike many provincial capitals, Semarang has never been an educational or cultural centre. The main cultural centres of Central Java are Yogyakarta and Surakarta.

Economy. The port of Semarang handles nearly all the imports coming into Central Java. The main exports include cloves, jute, kapok, pepper, sugar, teak, and tobacco.

Semarang has no heavy industry, but it has factories which make glassware, umbrellas, and weighing instruments. Factories in the surrounding areas produce textiles. The city is famous in Indonesia for its tobacco products. These include cut tobacco, ordinary cigarettes, and Indonesian *kretek* cigarettes, which contain cloves and burn with a crackling noise. Semarang is a major trading centre for Central Java, and has several large shopping districts. Roads and railways link Semarang with all the main cities of Java. Airlines connect Kali

Banteng Airport, 12 kilometres west of Semarang, with Jakarta, Yogyakarta, and Surabaya.

History. According to local legend, the ship of the Chinese admiral Cheng Ho sank off Japara, north of Semarang, in 1433. The Chinese erected the Sam Po Kong temple in his honour and placed inside an anchor believed to have come from his ship. The town of Demak, 25 kilometres east of Semarang, was the centre of the Muslim kingdom of Demak which lasted from 1500 to 1546. It has the oldest and most venerated mosque in Indonesia. People believe that the mosque was built by the Wali Sanga, the nine Muslim teachers who spread Islam throughout Java (see *Wali Sanga*).

See also **Indonesia**.

Semenov, Nikolai N. (1896-1986), was a Soviet scientist who shared the 1956 Nobel Prize for chemistry with Sir Cyril Hinshelwood. Semenov wrote many publications based on his research work in chemical kinetics and chemical reactions that release large amounts of energy. He proposed theories to account for the mechanism of many complex chain reactions.

Semicolon. See **Punctuation**.

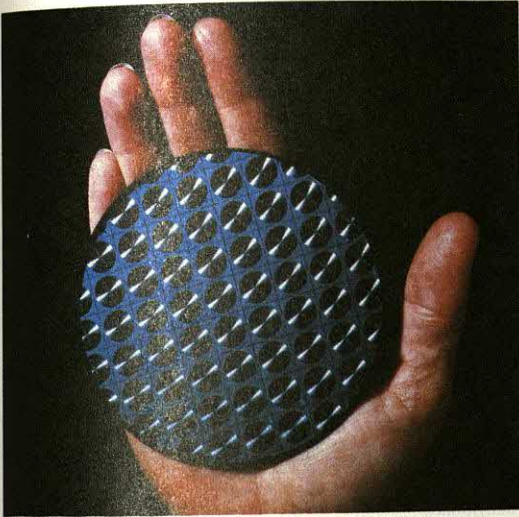
Semiconductor is a material that conducts electricity better than insulators like glass, but not as well as conductors like copper. Such materials have made possible modern computers and other important electronic devices. The *transistors* used in tiny pocket radios are semiconductor devices. So are the *solar cells* that provide electric power in artificial satellites. Silicon is the most widely used semiconductor material. Other semiconductor materials include cuprous oxide, germanium, gallium arsenide, gallium phosphide, indium arsenide, lead sulphide, selenium, and silicon carbide.

Electronic devices made of semiconductor materials can perform many functions, including those of vacuum and gas-filled tubes. However, semiconductor devices have a number of advantages over these tubes. Semiconductor devices use much less power than tubes, they last longer, and they can be built much smaller. One example of a tiny semiconductor device is the silicon chip used in computers and calculators. These devices are also called *microchips* and can contain up to several millions of diodes or transistors on a single chip.

Like tubes, semiconductor devices can *rectify* (change alternating current to direct current). They can also amplify weak electric signals. Radios, television sets, and other electronic devices depend on rectifiers, amplifiers, and oscillators. Some semiconductor devices can make light, and others can detect light. Most television camera tubes are semiconductor devices.

Basic principles. In ordinary copper wire, the copper atoms have electrons that are free to move from atom to atom. Such a flow of electrons makes up an electric current. In an ideal state, semiconductor materials would be insulators because they would have no free electrons. But if very small amounts of certain impurities such as antimony, arsenic, or phosphorus are present, a few free electrons are produced that can move and form an electric current. These semiconductors are known as *n-type* semiconductors.

Another type of semiconductor, called *p-type*, is formed by adding small quantities of other impurities such as aluminium, boron, or gallium. These impurities take electrons away from a few atoms of the semicon-



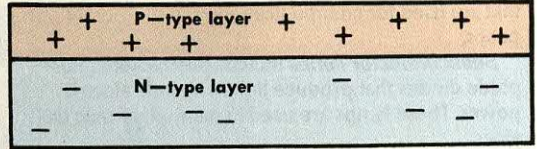
This **semiconductor wafer** consists of solar cells, which convert the energy of sunlight into electrical energy.

ductor. This lack of an electron in an atom is called a *hole*. A hole can pass from one atom to another. A flow of such holes passing from atom to atom also forms an electric current.

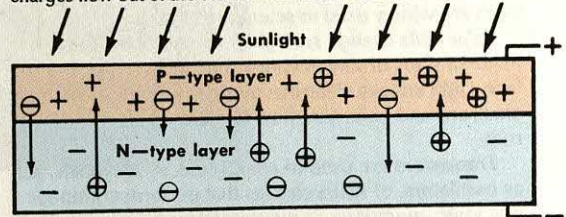
The abbreviation *n* means *negative*, referring to the negative charge of the electrons in n-type materials. Similarly, *p* means *positive*, referring to the positive charge associated with holes in p-type materials.

Semiconductor materials must be exceptionally pure to work properly. Scientists have developed special techniques to obtain pure crystals of semiconductor materials and to add the right amounts of impurities.

Semiconductor devices include semiconductor diodes, semiconductor lamps, semiconductor lasers, semiconductor radiation detectors, solar cells, and tran-



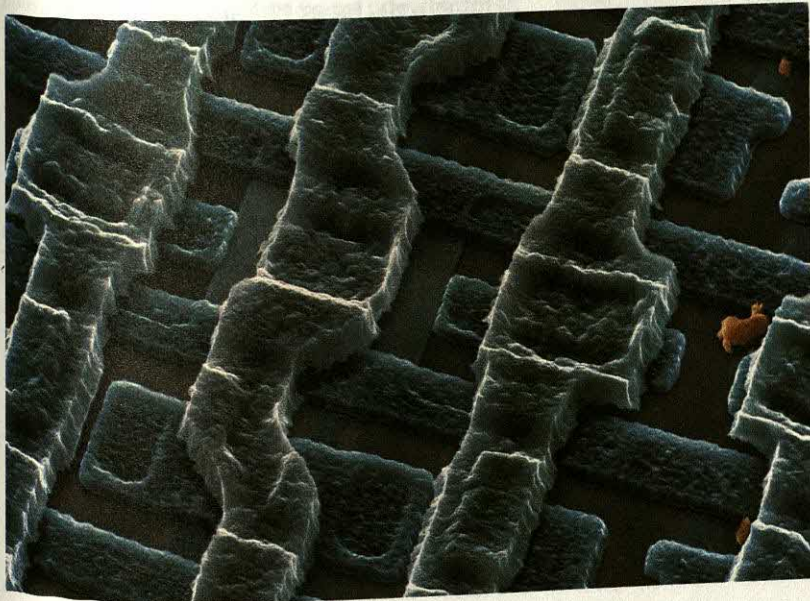
A silicon cell consists of two layers of silicon joined together. An electric field keeps *holes* (positive charges) in the p-type layer and *electrons* (negative charges) in the n-type layer, *above*. Sunlight produces additional charges (circles, *below*) that are driven into the positive and negative layers by the electric field. These charges flow out of the cell as an electric current.



sistors. These devices are formed by making certain regions in a semiconductor either p- or n-type.

Semiconductor diodes allow current to flow in only one direction, and are used as rectifiers. They have a piece of gallium arsenide, germanium, or silicon with an n-type region and a p-type region. The area where the two regions touch is called a *p-n junction*. When the p-type region has a positive charge and the n-type region has a negative charge, the p-type attracts electrons from the n-type, and the n-type attracts holes from the p-type. Thus, electric current flows across the p-n junction. If the p-type region is made negative and the n-type region is positive, almost no current will flow across the junction. The p-type then repels electrons in the n-type, and the n-type repels holes in the p-type.

Other semiconductor diodes, such as the Esaki or tunnel, Gunn, IMPATT, and LSA diodes can oscillate. They generate extremely high frequency radio waves



Integrated circuits contain electronic devices formed on semiconductor material. Silicon is the most widely used semiconductor material. The circuit on the left is part of a Random Access Memory (RAM) chip, greatly magnified. The chip contains thousands of sections like this. The orange specks are unwanted debris.

that are used for communications, radar, or other purposes.

Semiconductor lamps include tiny gallium phosphide diodes that produce light with little electric power. These lamps are used in many electronic devices.

Semiconductor lasers produce narrow beams of intense light. They are efficient lasers, but their light covers a wider frequency range than the light from other lasers.

Semiconductor radiation detectors indicate the presence and intensity of gamma rays and X rays. These devices are widely used in scientific research.

Solar cells change sunlight into electricity. They are made of slabs of silicon with a p-n junction near the surface. Light knocks electrons out of the atoms, producing electrons and holes that flow to make an electric current.

Transistors are used to amplify electrical signals, act as oscillators, or make circuits that perform arithmetic and logic operations. Some transistors have more than one p-n junction.

Related articles in *World Book* include:

Diamond (Synthetic diamonds)	Solid-state physics
Electronics (Solid state devices)	Solar energy (Capturing solar energy)
Hall effect	Transistor
Integrated circuit	
Laser	

Semilunar valve. See **Heart** (Parts of the heart; How the heart works; picture).

Seminary is a college for training future clergy and lay leaders for churches or other religious organizations. It may also be called a *theological college* or a *divinity school* and is commonly a graduate-level institution. Seminary students generally study doctrine, history, philosophy, and sacred writings of their religion. Many also study practical subjects, such as pastoral psychology, religious education, worship, and preaching. Seminaries in a number of countries offer higher degrees, such as master's and doctor's degrees. Some religious groups award diplomas, licenses, or certificates instead of degrees.

Semiramis was a mythical queen of Assyria. She supposedly founded the ancient city of Babylon, and conquered Persia (Iran) and Egypt. She was the daughter of a Syrian youth and a fish goddess. Her mother left her, and she was fed by doves. Semiramis grew to be a beautiful woman and married King Ninus of Assyria. She became queen when he died, and won many battles, but her son overthrew her. Herodotus mentions a Semiramis who was queen of Babylon in the 700's B.C.

Semites are peoples who speak a Semitic language, such as Arabic or Hebrew. They live mainly in Ethiopia, Iraq, Israel, Jordan, Lebanon, Syria, the Arabian Peninsula, and North Africa. The ancient Assyrians, Babylonians, Canaanites, Eblaites, Hebrews, and Phoenicians also were Semites.

Semitic peoples gave the world the alphabet and the idea of one God. Three great religions—Judaism, Christianity, and Islam—originated among Semitic peoples.

The origin of the Semites is unknown, but some anthropologists believe these peoples may have been nomads who lived on the Arabian Peninsula. By about 3,000 B.C., the ancient Semites had moved to the lower

part of Mesopotamia (now southeastern Iraq), the home of the Sumerian civilization (see **Sumer**).

A Semitic ruler named Sargon founded the first Semitic empire in the 2300's B.C. in Akkad, a city in Mesopotamia. Under Sargon's rule, Semitic and Sumerian culture spread throughout Mesopotamia. At about the same time, Semitic dynasties and states emerged in Syria.

Almost 3,000 years ago, Semitic peoples established colonies in parts of Africa, Sicily, and Spain. Semitic culture was later absorbed by non-Semitic peoples who moved into those areas.

The word *anti-Semitism* means hatred of Jews or prejudice against Jews. But the term is misleading because not all Jews are Semites, and Semites include not only Jews but also Arabs and other peoples.

Related articles in *World Book* include:

Anti-Semitism	Ebla	Phoenicia
Arabs	Hebrew language and literature	Sargon of Akkad
Assyria		Semitic languages
Babylonia	Jews	

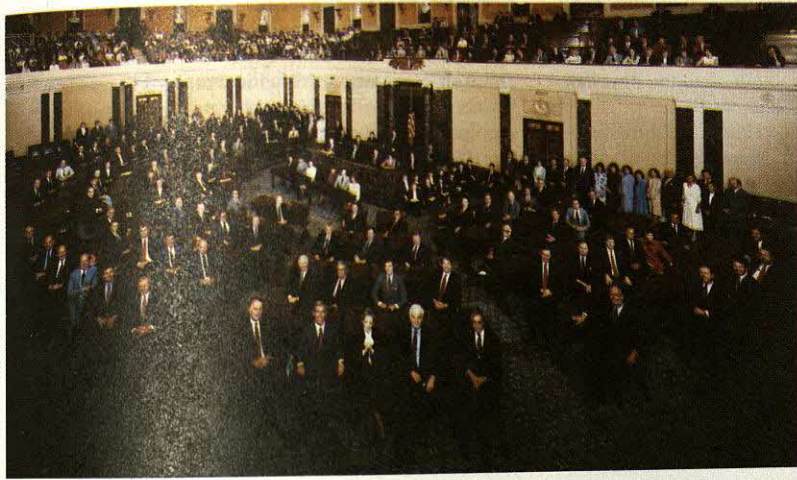
Semitic languages are among the world's oldest languages. They are generally divided into three categories: North East Semitic (Akkadian); North West Semitic (Hebrew, Aramaic, Eblaites); and Central and Southern Semitic (Arabic, South Arabian, Ethiopic). Amharic, Arabic, Hebrew, and Tigre are the principal spoken Semitic languages today. Aramaic survives as a spoken language in a small number of communities of Assyrian Christians in the Middle East, but otherwise it is used mainly for religious purposes.

Documents in Akkadian and Eblaites have been found on tablets written in *cuneiform*, an ancient system of writing that featured wedge-shaped characters. The alphabets of the other Semitic languages developed from a common source but gradually developed into the separate writing systems of Hebrew and Arabic used today.

See also **Alphabet**; **Arabic language**; **Aramaic language**; **Cuneiform**; **Hebrew language and literature**; **Semites**.

Semmelweis, Ignaz Philipp (1818-1865), was a Hungarian doctor who first used antiseptic methods extensively in childbirth. At the Vienna General Hospital, he discovered that puerperal fever, which then killed about 12 mothers out of every 100, was contagious, and that doctors themselves were spreading the disease by not washing their hands between examining patients. He was ridiculed for this idea. But he maintained his stand, and in 1860 published his classic work on *The Etiology, Concept and Prophylaxis of Childbirth Fever*. Opponents of his ideas attacked him fiercely, and this battle eventually brought on mental illness. The year of Semmelweis's death, Joseph Lister performed his first antiseptic operation, and soon afterward it was recognized that Semmelweis had been right. Semmelweis was born in Budapest.

Sempach, Battle of. See **Winkelried**, **Arnold von**. **Senate** is one of the two lawmaking bodies of many legislatures. In many of these legislatures, the other chamber is called a *house of representatives*. In most cases, the senate is the smaller chamber. Many countries have a national legislature with a senate, including the United States, Canada, Australia, France, Italy, and the Republic of Ireland.



The United States Senate, which has 100 members, meets in the Senate chamber of the United States Capitol, left. A gallery in the chamber allows visitors to watch the senators at work.

Almost half of all nations have a two-house legislature. However, not all upper houses are called senates. Many nations have representation by population in the lower house and equal representation for each state or province in the upper house.

Most upper houses that are not directly chosen by the voters have important limits on their power. For example, the Canadian Senate, whose members are appointed by the governor general on the prime minister's recommendation, cannot introduce bills involving the spending of money, and cannot stop the passage of a constitutional amendment approved by the House of Commons. Ireland's senate, which is partly appointed and partly elected by other officials, serves mainly as an advisory body.

The U.S. Senate. The U.S. Senate is one of the two houses of Congress. The other one is the House of Representatives, usually called simply the *House*. The Senate is often referred to as the *upper house* and the House of Representatives as the *lower house*. Both houses have about the same amount of power, but the office of senator is considered a higher distinction than that of representative.

The House and Senate must pass identical versions of a bill before it can become law. The Senate can generate all types of legislation except tax laws. Only the Senate can approve treaties and the president's nominations to certain government offices.

The Constitutional Convention, which established the form of the national government in 1787, disagreed on the question of congressional representation. Delegates from the states that had small populations wanted equal representation for every state. But delegates from states with large populations called for representation according to population. A compromise provided for equal representation in the Senate—two senators from each state, regardless of population. The agreement set up representation in the House based on population. The first Senate had 22 members when it met in 1789, and 26 by the end of the first Congress. The Senate now has 100 members. Its membership reached 100 in 1959, when Hawaii became the 50th state of the United States.

Considering legislation is the Senate's chief task. After a senator introduces a bill, it is sent to a committee for

study. The committee may lay the bill aside, keeping the Senate from voting on it, or release it with a recommendation to pass it. If a bill is released, it goes on a list for consideration by the Senate. The majority leader largely determines if and when such bills are considered.

The Senate considers most bills under a *unanimous consent agreement*. Such an agreement allows more flexible procedures than would otherwise be allowed. An objection from even one senator blocks a unanimous consent agreement. Most of these agreements include a limit on debate. Under the normal rules of the Senate, members may speak for as long as they wish on any topic whatsoever. Some senators occasionally use this freedom so they can make long speeches called *filibusters*, which prevent the Senate from voting. Small groups of senators sometimes use filibusters to force the withdrawal or changing of legislation that is favoured by most members. To end a filibuster, the Senate can vote *cloture*—that is, it votes to limit the debate. Cloture requires the support of at least three-fifths of the Senate.

Most bills require the support of only a simple majority—that is, more than half the senators present—to pass. A bill that the Senate has originated and passed is sent to the House where it goes through a similar process. If both houses pass a bill, a conference committee may resolve any differences between the two versions of the legislation. After both houses pass identical versions of the bill, it goes back to the president for approval. The bill becomes law if the president signs it or fails to act on it for 10 days—not including Sundays—while Congress is in session. A bill requires the president's signature to become law if it reaches the chief executive fewer than 10 days—not including Sundays—before Congress adjourns. If the president vetoes the bill, it is sent back to Congress. A vetoed bill becomes law if at least two-thirds of the members present in each house vote to *override* (reverse) the veto.

The Australian Senate. In Australia, the Senate is the upper house of the federal Parliament. The lower house is the House of Representatives. The Senate consists of 76 members representing the six states and two mainland territories of Australia. Each of the states elects 12 senators, who serve six-year terms. Normally, elec-

tions for the Senate coincide with general elections to the House of Representatives, which usually take place every three years. This means that each state elects six senators at one election and another six at the next. The mainland territories elect two senators each.

The Senate, like the Australian House of Representatives, may introduce legislation, express its opinions, or pass resolutions. Both it and the House of Representatives must give their assent to a bill before it can become law. But the Senate has no power to introduce money bills, authorizing taxation or public expenditure. Nor can it amend such bills. These functions belong to the House of Representatives alone. However, the Senate can reject a money bill outright, or it can suggest amendments but not pass them.

In practice, the Senate function is to review bills passed by the House of Representatives. It can reject them. But the party or coalition that controls the House usually controls the Senate too. As a result, the Senate seldom rejects bills that the House passes.

The Irish Senate is officially known as *Seanad Éireann* or the Seanad. It is the upper house of the *Oireachtas* (parliament of the Republic of Ireland). The lower house is known as *Dáil Éireann* or the Dáil. The Seanad has fewer powers than the Dáil. It can recommend new laws to the Dáil and suggest amendments to laws passed by the Dáil. But the Dáil can accept or reject the Seanad's suggestions and proposals as it pleases. The Seanad can delay a law passed by the Dáil for up to 90 days. But it cannot block any measure permanently. Seanad Éireann has 60 members appointed for five-year terms.

The *taoiseach* (prime minister) nominates 11 senators, and the National University of Ireland and the University of Dublin each nominate 3. The remaining 43 represent various interests. These 43 senators are elected by 990 voters from the Dáil, the Seanad, and local government authorities.

Related articles in *World Book*. See the *Government* section of the article on each country mentioned, such as Italy (Government). Other related articles include:

Australia, Government of	Ireland, Government of
Canada, Government of (The Senate)	Parliament (The House of Lords)



Senate committees hold hearings to gather information about proposed laws. The committees decide whether to lay the bills aside or to recommend that the full Senate pass them.

Sendak, Maurice (1928–), is an American illustrator and writer of children's books. Many of his illustrations and tales express the fears and other emotions of children. He imaginatively incorporates the people, events, and recollections of his own childhood in his works. Sendak won the distinguished American award, the 1964 Caldecott Medal, for his illustrations for *Where the Wild Things Are*, which he also wrote.

Maurice Bernard Sendak was born in Brooklyn, New York. His illustrations appear in many books, including *The Wheel on the School* (1954), *Lullabies and Night Songs* (1965), *Zlateh the Goat and Other Stories* (1966), *In the Night Kitchen* (1970), *Outside Over There* (1981), and *Dear Mili* (1988).

Sendak has also designed sets for ballets and other stage productions. In 1970, he became the first American illustrator to win the international Hans Christian Andersen Award. Sendak's essays on children's literature were collected in *Caldecott & Co.* (1988).

Seneca, Lucius Annaeus (4 B.C.?–65 A.D.), was a Roman statesman, author, and Stoic philosopher. His surviving works include 12 philosophic essays, 124 letters, a meteorological essay, a satire, and 9 tragedies. His tragedies adapt subjects used by the Greek playwrights. But they are intense, violent melodramas full of rhetorical language. They focus on the Stoic belief that catastrophe results when passion destroys reason. The plays widely influenced tragic drama in Italy, France, and Elizabethan England.

Seneca was born in Spain into a distinguished Roman family. He was prominent in political and literary life in Rome. Later he became the tutor and adviser of the Emperor Nero. Nero accused Seneca of plotting his death, and forced him to commit suicide.

See also **Geology** (The Romans).

Senefelder, Alois (1771–1834), invented the process of lithography (see **Lithography**). As a young man, Senefelder wrote plays. Because he could not get them published, he tried to print them himself. While preparing to etch a stone slab, he wrote on it with a wax crayon and found that the marks could be inked and printed. He was born in Munich, Germany.

Senegal is a country on the northwest coast of Africa. It lies at the tip of the huge bulge of northern Africa that juts westward toward the Atlantic Ocean. It extends farther west than any other African mainland nation.

Senegal covers 196,722 square kilometres. For Senegal's total population, see the *Facts in brief* table with this article. The vast majority of the people are black Africans. Rolling plains cover most of the country. The tiny nation of Gambia divides the southern part of Senegal, called the *Casamance*, from the larger northern part. Dakar is Senegal's capital and largest city.

Senegal became an independent nation in 1960. It had been ruled by France since the late 1800's.

Government. Senegal is a republic. A president heads the government and appoints a prime minister and Cabinet members to carry out the operations of the government. A National Assembly serves as Senegal's lawmaking body. The president approves or rejects all laws that are passed by the Assembly. Senegal's judicial system consists of the Supreme Court and three lower courts.

The president and the members of the National As-

sembly are elected by the people to five-year terms. All citizens that are 21 years old and older may vote. Senegal has a number of political parties. But the Socialist Party of Senegal has controlled the government since the country became independent in 1960. The president and most other government officials in Senegal belong to the Socialist Party of Senegal.

People. About 95 per cent of Senegal's people are black Africans. They belong to many different ethnic groups. The largest ethnic groups are, in order of size, the Wolof, Fulani (or Fula), Serer, Toucouleur, Diola, and Mandingo. Each group has its own customs and language.

Senegal also has a large immigrant population made up of people from other African countries and from France and Lebanon. French is Senegal's official language, but Wolof is the most widely spoken language in the country.

About 85 per cent of Senegal's people are Muslims. The rest are either Christians or people who practise traditional African religions. Most Senegalese Muslims belong to Islamic religious groups called *brotherhoods*. The two largest groups are the Muridiyya (or Mouride) brotherhood and the Tidjaniyya brotherhood. Brotherhoods are led by Muslim religious leaders called *marabouts*. Marabouts are important in Senegalese politics because they can influence the way their followers vote.

About 60 per cent of Senegal's people live in rural areas, and about 40 per cent live in urban areas. Most of the rural houses are mud huts with thatched roofs. In many cases, a group of related families lives together in a *compound* (cluster of houses) surrounded by a wall or fence. In the cities, middle-class people live in modern flats or bungalows. The poor live in flimsy dwellings made of mud, sticks, or boards.

Most Senegalese men wear wide-legged trousers and a loose-fitting cotton robe called a *boubou*. The women wear brightly coloured boubous, jewellery, and turbans. The basic food of most Senegalese is a kind of grain called *millet*. Favourite dishes include chicken stew, spicy fried fish, and meat or fish with peanut sauce.

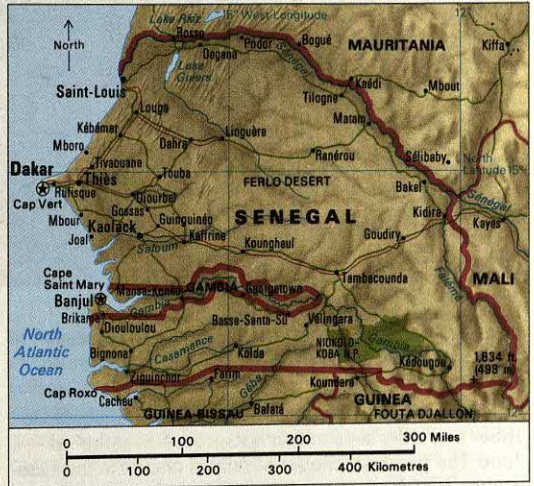
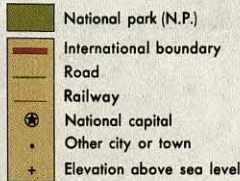
Senegal faces severe health problems. Water and food contaminated by parasites and other impurities are a major cause of illness and death in the country, especially in the rural areas. Senegal has a severe shortage of doctors.

Only about 10 per cent of Senegal's adult population can read and write. Children are required by law to complete six years of schooling, but the law is not enforced. About 55 per cent of Senegal's children attend primary school, and 10 per cent go to secondary school. Relatively few Senegalese attend college. The University of Dakar is Senegal's only university.

The Senegalese are noted for the striking wooden carved masks they produce and for their artistic traditional dances. The government of Senegal regularly sponsors exhibits of art from Senegal and from other African countries.

Land and climate. Sandy beaches cover Senegal's coast, which extends about 499 kilometres along the Atlantic Ocean. High sand dunes rise along the northern part of the coast. Dakar lies along the coast, on a peninsula called Cap Vert. Inland, Senegal's terrain consists

Senegal



mainly of gently rolling plains covered with reddish sand. The foothills of the Fouta Djallon mountain range rise in the southeast, near Senegal's border with Guinea.

Forests cover the Casamance region in southern Senegal. Farther north, the amount of plant life gradually decreases. Much of Senegal's wildlife has been eliminated by hunting and by the use of land for housing and other development. However, antelope, crocodiles, chimpanzees, elephants, and other kinds of wildlife still live in the eastern and southern parts of the country. Senegal has three major rivers—the Sénégal in the north, the Gambia in the southeast, and the Casamance in the southwest.

Facts in brief about Senegal

Capital: Dakar.

Official language: French.

Official name: République du Sénégal (Republic of Senegal).

Area: 196,722 km². **Coastline:** 499 km.

Elevation: Highest—498 metres, in the southeast. **Lowest**—sea level.

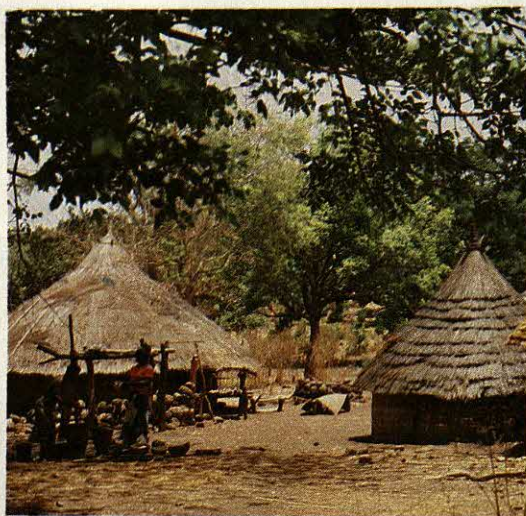
Population: Estimated 1996 population—8,610,000; density, 42 people per km²; distribution, 62 per cent rural, 38 per cent urban. 1988 census—6,928,405. Estimated 2001 population—9,829,000.

Chief products: Agriculture—peanuts, millet, cassava, cotton, poultry, rice, vegetables. Manufacturing and processing—peanut products, fish products, refined petroleum, flour milling. Mining—phosphates.

Flag: The flag has green, yellow, and red vertical stripes. A green star lies in the centre of the yellow stripe. See Flag (picture: Flags of Africa).

National anthem: "Pincez Tous Vos Koras, Frappez les Balafons" ("Pluck Your Koras, Strike the Balafons").

Money: Currency unit—franc. One franc = 100 centimes.



Rural houses in Senegal typically have mud walls and thatched roofs. In many cases, related families group their houses in a compound, where they share meals and chores.

Senegal has a rainy season that lasts from July to October and a dry season that lasts from November to June. The greatest amount of rainfall occurs in the Casamance, which receives about 150 to 180 centimetres annually. The amount of rainfall gradually decreases farther north, averaging less than 50 centimetres near the Sénégal River. The average annual temperature along Senegal's coast is about 22° C. Inland, the average annual temperature is about 29° C.

Economy. Senegal is a developing nation. Poverty is widespread in the country. However, economic conditions have improved gradually since independence was gained in 1960.

About three-fourths of Senegal's people work in agriculture. Senegalese farmers grow millet, cassava, rice, vegetables, and other crops for their own use. The farmers' main source of income comes from the sale of pe-



An Independence Day festival in Dakar, the capital of Senegal, is marked by the display of the national flag and the playing of *kora*, stringed instruments made from gourds.

anuts. Poultry and cotton are also important income-producing farm products.

The processing of peanuts into peanut oil and oil cakes ranks as Senegal's chief industry. Other important industries include fishing, the processing of fish, flour milling, and the refining of petroleum imported from Algeria and Gabon. Phosphates from lime deposits are Senegal's chief mineral products.

Peanuts, phosphates, and fish products rank as Senegal's leading exports. Major imports include food, machinery, and electrical equipment. The country imports all of its petroleum and coal because it has no natural supplies of these minerals. France has been Senegal's main trading partner since the 1800's, but Senegal also trades with other countries in Africa and elsewhere. About three-fourths of Senegal's foreign trade goes through Dakar, one of the busiest ports in Africa.



The University of Dakar is Senegal's only university. It offers a variety of courses, and specializes in local African studies. Its modern library, left, is an outstanding architectural feature of the campus.

Senegal has one of the finest transportation systems in western Africa. The system includes about 11,000 kilometres of roads and about 1,100 kilometres of railways. An international airport is located in Dakar. One major newspaper and several magazines are published in Senegal. There are about 420,000 radios and 230,000 TV sets in the country.

History. The area that is now Senegal has probably been inhabited by black Africans since prehistoric times. The ancient West African empires of Ghana, Mali, and Songhai controlled eastern parts of the area from the A.D. 300's to the 1500's. Between the 1000's and 1300's, independent kingdoms arose in Senegal, including the Toucouleur kingdom in the north and the Serer and Wolof kingdoms near the central region.

In the mid-1400's, Portuguese sailors discovered the mouths of the Sénégal, Gambia, and Casamance rivers. They sailed into the interior of Senegal and began trading with the people. England, France, and the Netherlands took over the trade from the Portuguese during the 1500's. By the mid-1600's, the Europeans had established trading posts along the coast. The Europeans bought slaves along the coast. They traded such goods as alcohol, cloth, jewellery, iron bars, and weapons for gold, ivory, millet, ostrich feathers, and other goods. The Europeans introduced peanuts into the area as a food crop for the slaves.

England, France, and the Netherlands fought each other for possession of the trading posts. The Netherlands lost its posts in the late 1600's. In 1817, the English turned over their last possessions in Senegal to the French. During the mid-1800's, French troops conquered the independent kingdoms in the interior of what is now Senegal. In 1882, France made Senegal a French colony with four administrative districts. In 1895, the colony became part of a large federation of French territories called French West Africa. Dakar became the federation's capital.

The period of French rule resulted in many changes



Senegal's inland terrain consists mainly of rolling hills covered with reddish sand. Forested sections lie in southern Senegal, where antelope and other kinds of animals live.

in Senegal. For example, marabouts replaced tribal chiefs as landlords and political leaders. The chiefs had lost much of their authority after France conquered their kingdoms. In addition, the French encouraged the Senegalese to increase the production of peanuts for export to make the colony economically self-sufficient. The French also established many schools in Senegal.

Many Senegalese began demanding independence during the mid-1900's. Senegal gained control of its internal political affairs in 1956. In 1959, the country joined the French Sudan (now Mali) to form the Federation of Mali. The federation gained independence from France on June 20, 1960. On Aug. 20, 1960, Senegal withdrew from the federation and became the independent Republic of Senegal. Léopold Sédar Senghor, the founder of the Socialist Party of Senegal, became president.

In 1962, Prime Minister Mamadou Dia was arrested



In Senegal, each village has its own water supply, usually a well or spring, which becomes a local meeting place. Senegal has a long dry season and a short rainy season. Therefore, some villages also store rainwater in large tanks. Most of the Senegalese people live in small rural communities.



Léopold Sédar Senghor, in the foreground, served as president of Senegal from 1960 until 1981. A democratic socialist, he encouraged *négritude*, which emphasized black ethnic and cultural pride.

for trying to overthrow President Senghor. The prime minister and others were tried and convicted. They were imprisoned from 1963 to 1974. In 1963, Senegal adopted a new constitution that eliminated the office of prime minister. However, in 1970, the people voted to restore the office. Severe droughts during the late 1960's and the 1970's seriously damaged Senegal's economy.

In 1981, Senghor resigned as president. Prime Minister Abdou Diouf succeeded him.

Senegal and Gambia have always had close relations. In 1981, troops from Senegal helped put down a rebellion in Gambia. In 1982, Senegal and Gambia formed a confederation called Senegambia. The confederation strengthened the economic ties between the two countries and united their armed forces.

Since independence, Senegal has also maintained close relations with France and has followed a pro-Western foreign policy. France provides Senegal with much economic aid, and French military advisers are stationed in Senegal.

See also **Dakar**; **French West Africa**; **Senghor, Léopold Sédar**; **Clothing** (picture: Traditional costumes). **Senescence**. See **Aging**; **Geriatrics**; **Senility**. **Senghor, Léopold Sédar** (1906-), was president of Senegal from 1960 to 1981. He also became famous for his poetry and his writings on politics, culture, and society.

Senghor was born in Joal, near Mbour, Senegal. Senegal was then part of the French colonial federation known as French West Africa. Senghor graduated from the University of Paris in 1931. He was a professor of Latin and of French language and literature in France in the 1930's and 1940's. During that time, Senghor and other black poets in Paris developed *négritude*, a philosophy that emphasized black ethnic and cultural pride.

Senghor became a representative of Senegal in the French National Assembly in 1946. In 1959, Senghor became one of the principal leaders of the Federation of Mali, a union between Senegal and what is today Mali. The union collapsed in August 1960. Senegal then be-

came an independent nation, with Senghor as president. Senghor helped promote economic progress and political stability in Senegal. His critics charged that he failed to bring about major social reforms and that he maintained too close ties with France, the former colonial ruler. Senghor resigned as president in 1981.

In his writings, Senghor promoted black African civilization and opposed more materialistic cultures of the West. He won several poetry awards. In 1983, Senghor became the first black to be elected to the French Academy, an organization of scholars and writers.

Senility is a general term used to describe certain mental problems that affect some elderly people. The term *senility* actually refers to a large number of conditions with an equally large number of causes. Thus, many experts on the problems of the elderly avoid using the term. None of the conditions associated with the term is an unavoidable part of aging, and many can be helped by prompt medical treatment.

The main symptoms associated with so-called senility include a serious loss of memory and a decreased ability to perform such mental tasks as reading or arithmetic. People with such problems also tend to forget the time and where they are. They may fail to recall common facts or to recognize people they know well. A variety of permanent or temporary physical changes in the brain can produce these symptoms. The two most common brain diseases that cause permanent damage are *multi-infarct dementia* (a more accurate term for what was once called *cerebral arteriosclerosis*) and *Alzheimer's disease* (also known as *senile dementia of the Alzheimer's type*). In multi-infarct dementia, arteries that nourish the brain become partially blocked and cannot supply the brain with enough oxygen-rich blood. As a result, the victim suffers a series of small strokes that destroy much brain tissue. Alzheimer's disease gradually destroys brain cells. Its cause is not fully understood.

Many other conditions, including head injuries, high fever, unfavourable drug reactions, and poor nutrition, can produce the symptoms of multi-infarct dementia, or

of Alzheimer's disease. In most cases, the symptoms can be eliminated by medical treatment. But such conditions can result in permanent brain damage if not treated.

Certain emotional problems can cause serious loss of memory or confusion in the elderly. Such problems include boredom, depression, loneliness, and worry. Elderly people can overcome or avoid most of these difficulties by engaging in a hobby or some other activity that keeps the mind and body active. A patient with severe depression should be treated by a psychiatrist, psychologist, or social worker.

See also **Aging; Alzheimer's disease; Geriatrics.**

Senior citizen. See **Old age.**

Sennacherib (reigned 704-681 B.C.) was king of Assyria, in what is now northern Iraq. Sennacherib ruled the Assyrian Empire during a period of revolt and war. He fought a long series of battles against Babylonia and its allies from Elam, in what is now Iran.

Sennacherib succeeded his father, Sargon II, as king. In 703 B.C., he ended a revolt of the Babylonians and Elamites led by Merodach-Baladan. Merodach-Baladan had been king of Babylonia until defeated by Sargon and was trying to regain his throne. Cities in Syria and Palestine revolted in 701 B.C. Sennacherib regained all except Jerusalem. He crushed a revolt in Babylonia in 689 B.C., and destroyed the city of Babylon as a warning to other rebels. He made Nineveh Assyria's capital and built a city there. In 681 B.C., his sons murdered him. Esarhaddon, a son who claimed to be innocent of the murder, became king.

Sennett, Mack (1884-1960), was a pioneer film director and producer who became famous for his slapstick silent comedies. Many of the top silent comedy stars appeared in his Keystone films. His violent and vulgar film world challenged social authority. His famous Keystone Kops, instead of imposing order, added to the chaos. Sennett's bathing beauties fell for rascals, played by comics like Roscoe "Fatty" Arbuckle, rather than respectable beaus. These and other characters were often in-

volved in famous chases that ended in spectacular crashes at the close of many Sennett films.

Sennett was born in Danville, Quebec, Canada. His real name was Michael Sinnott. He directed and produced hundreds of silent short comedies, beginning in 1911. His career came to a virtual end soon after the arrival of sound films in the late 1920's.

Senses are the means by which many-celled animals tell what is happening in their environment. Many people think that human beings have only five senses—hearing, sight, smell, taste, and touch. But there are other kinds of senses that give information about the position and movement of the body and about body needs. These senses include balance, hunger, pain, and thirst.

Scientists divide the senses into two groups. *External senses* receive information about the outside environment—about things outside the body. The external senses include hearing, sight, smell, taste, and touch. They also include the sense of heat, which is felt by special *receptor* (receiver) cells in the skin. *Internal senses* receive information about the internal environment—about the changes that occur in organs and tissues.

External senses. Some external senses detect things that occur far from the body, and others detect things that come in contact with it. We detect things in the distant outside environment with our senses of sight, hearing, and heat. These senses are called *distance receiving senses*. They require only a small stimulus to respond. This high level of sensitivity is necessary because the stimulus may occur far away from the sense receptor. Therefore, the amount of energy that actually reaches the sense receptor is often very small.

The senses of taste, touch, and smell involve contact with the body and are called *contact external senses*. They require a fairly large stimulus to respond. For example, many thousands of molecules of a substance must be present for something to be tasted. Relatively heavy pressure must be applied to the skin for an object to be felt. Because these stimuli occur at the receptors, contact external senses do not need high sensitivity.

Internal senses detect changes that take place inside the body and send messages about these changes to the brain. The internal senses respond to chemical and physical stimuli in the circulatory, digestive, excretory, respiratory, and central nervous systems. They contribute to such feelings as hunger, fatigue, pain, and thirst. They also respond to the position and movement of the head and the joints, and to tension in the muscles. By responding to these chemical and physical changes, internal senses help maintain a proper environment inside the body. They also provide information on relationships between the body and the outside world.

The internal senses can be highly sensitive to small changes in the amounts of chemicals that are usually present in the body. This high sensitivity is necessary because the internal receptors must maintain a rather constant internal environment for life to continue. The receptors that respond to chemical changes in the body are called *internal chemoreceptors*.

Some animals respond to environmental stimuli that cannot be detected by human senses. These stimuli include ultraviolet light, the earth's magnetic field, sounds of very high and very low frequencies, and extremely small electric currents in water.



A Mack Sennett comedy called *Tillie's Punctured Romance* (1914) featured three famous silent film stars. They were, left to right, Charlie Chaplin, Marie Dressler, and Mabel Normand.

Our external and internal senses

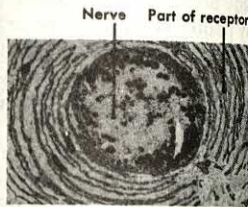
Our senses are divided into two main groups. *External senses* tell us about things that occur far from the body and that come in contact with it. *Internal senses* give us information about changes that occur in the tissues and organs inside our bodies.

External senses

The external senses of hearing, heat, and sight tell us about things that happen far from the body. The external senses of taste, touch, and smell tell us about things that come in contact with the body. The diagram on the right shows where the receptors of these senses are located.

Smell
(olfactory nerves)
Sight
(retina of eye)
Hearing
(cochlea of ear)
Taste
(taste buds on tongue)
Touch
and heat (receptors in skin)

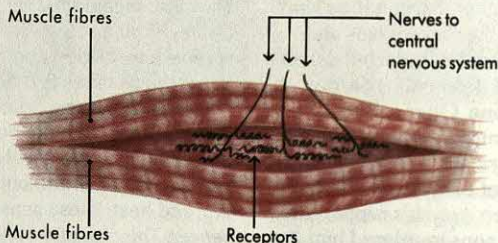
External senses and their receptors



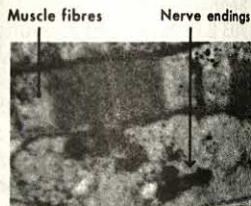
The end of a nerve is magnified 2,000 times. The nerve leads from a touch receptor.

Internal senses

The internal senses send messages to the brain about changes inside the body. The senses control such feelings as fatigue, hunger, pain, and thirst. They also respond to tension in the muscles. The diagram on the right shows the receptors that sense tension in muscle fibres.



Receptors of the internal sense of muscular tension



Nerves of a muscle tension receptor, magnified 6,000 times, connect to muscle fibres.

By studying the senses, scientists are able to determine what things in the environment are important to each kind of animal. They also learn about the environment in which the *evolution* (gradual development) of particular groups of animals occurred.

Related articles in *World Book* include:

Animal (The senses)	Muscle sense	Smell
Brain	Nervous system	Taste
Ear	Nose	Thirst
Eye	Pain	Touch
Hunger	Perception	
Insect (The senses)	Sleep	

Sensitive plant is a small, spreading shrub that grows in the tropics of the Western Hemisphere. The plant is called *sensitive* because its leaflets fold together when touched or exposed to strong fumes. At the same time, the leafstalks bend toward the main stem, as though they were shrinking from being touched.

Sensitive plants are sometimes grown in greenhouses as curiosities. Leaves of many members of the pea family close at night.

Scientific classification. The sensitive plant belongs to the pea family, Leguminosae (Fabaceae). It is *Mimosa pudica*.

See also **Telegraph plant**.

Sensitivity training is a learning process designed to develop an individual's self-awareness and sensitivity to other people and the environment. Sensitivity training takes place in a group of from 8 to 20 people, including a leader. Members of this *encounter group* speak openly about their feelings and reactions to others in the group. Some group leaders involve members in various

games to produce strong emotional experiences. These games include such activities as having two members stare into each other's eyes, or having a member act out a feeling of affection or anger.

Some psychologists regard sensitivity training as a major development in their field. They believe it can make a person more aware of inner feelings and help the person get along more effectively with others.

Other psychologists criticize sensitivity training. They call it experimental and claim that its effectiveness has not been proved. They declare that many group leaders lack proper training. Such critics also believe that encounter groups do not take enough care to exclude



Leaves of the sensitive plant react quickly after they are touched or exposed to strong fumes. The open leaves are shown at the left. After being touched, they fold up tightly, right.

people who might react badly to sensitivity training. They point out that some participants have been physically or psychologically injured at meetings.

Kurt Lewin, a German-born psychologist, conducted the first encounter group at an interracial workshop in New Britain, Connecticut, U.S.A., in 1946. The Esalen Institute in Big Sur, California, also in the United States, developed and popularized sensitivity training during the 1960's.

Sensory neuron. See *Nervous system* (How the nervous system works).

Sentence is a series of words arranged into a meaningful unit. It begins with a capital letter and ends with a punctuation mark—a full stop, a question mark, or an exclamation point. A grammatically complete sentence consists of an independent group of words that has a subject and a predicate. The predicate must include a *finite verb*. Such a verb, with a subject, can form a sentence—for example, *The lightning flashed*.

The group of words *The potatoes cooking* has a subject, but it is not grammatically complete because it lacks a finite verb. *The potatoes are cooking* is a grammatically complete sentence because it has a subject and a finite verb. *When the potatoes are cooking* is not a sentence because it is not an independent group of words. The word *when* makes it a subordinate clause. Sentences must be main clauses. See *Clause*.

Subject and predicate. The subject of a sentence consists of a noun or another word used as a noun, plus its modifiers. The subject tells what is being spoken about. In *The latest issue of the magazine arrived today*, the subject is *issue*. The modifiers are *The, latest, and of the magazine*. Together, the six words form the *complete subject*. In *Vigorous bicycling is good exercise*, the subject is *bicycling*. Its modifier is *vigorous*. The two words together make up the complete subject.

A predicate consists of a finite verb, along with its object or complement and their modifiers. The finite verb may be transitive, intransitive, or a linking verb. A *transitive* verb passes the action from the subject to a direct or indirect object. The meaning of an object may be completed by a noun or adjective called a *predicate complement*. An *intransitive* verb describes a completed action and needs no object. A *linking verb* connects the subject with a predicate noun, pronoun, or adjective that completes the meaning of the subject and is called a *subjective complement*. See *Verb*.

As a unit, the predicate tells something about the subject. In *Our class sold homemade biscuits, sold home-made biscuits* says something about the subject *Our class*. The verb is *sold*; the object is *biscuits*, and its modifier is *home-made*. Together, they form the *complete predicate*. In *The young boy became very ill, became very ill* comments upon the subject *The young boy*. *Became* is the verb; *ill* is the predicate complement, and *very* is its modifier. Together, they form the complete predicate.

A *compound subject* consists of two or more nouns: *Hydrogen and oxygen combine to form water*. A *compound predicate* consists of two or more finite verbs: *Water can be frozen into a solid or can be heated into a gas*.

Sentence classifications. A sentence can be classified by its purpose. If the purpose of a sentence is to

state a fact, it is a *declarative* sentence: *I found some coins*. If it asks a question, it is an *interrogative* sentence: *Did you find some coins?* If it gives a command or makes a request, it is an *imperative* sentence: *Lend me some money, please*. If it expresses strong feeling, it is an *exclamatory* sentence: *How lucky I was to find some money!*

A sentence can also be classified by its grammatical form. A *simple sentence* has one subject and one predicate: *The wind blew fiercely*. But either the subject or the predicate can be compound: *Oranges and lemons are citrus fruits* has a compound subject. *The cat snarled and scratched* has a compound predicate.

A *compound sentence* joins two or more simple sentences. The sentences are joined with a conjunction, such as *and, but, or, for, nor, or yet*: *I wrote to her, but she did not reply*. A *complex sentence* consists of a main clause and one or more subordinate or dependent clauses: *Animals bite when they are teased or when they are attacked*.

Sentence patterns. The variety of English sentences may be shown by examining how several basic sentence patterns can be changed. Such basic patterns are sometimes called *kernels*.

Pattern I

Subject	Intransitive verb	(Optional adverb)
Thorns	hurt	(badly).
The fish	are biting	(today).

Pattern II

Subject	Transitive verb	Direct object	(Optional objective complement)
The farmer	planted	beans.	
The teacher	appointed	him	(chairman).

Pattern III

Subject	Transitive verb	Indirect object	Direct object
Singing	gives	me	pleasure.
John	made	himself	a guitar.

Pattern IV

Subject	Linking verb	Predicate noun
Mrs. Haley	is	my teacher.
He	turned	traitor.

Pattern V

Subject	Linking verb	Predicate adjective
Prices	are	high.
His voice	sounded	thin.

Basic sentence patterns can be added to, reduced, combined, and rearranged in many ways. The construction of sentences affects the clarity, emphasis, and pace of speaking and writing. A speaker varies sentences naturally, but a writer must do so consciously. Changing the parts of a sentence to vary a basic pattern is called *transformation*. Below are some transformations.

1. Some patterns may be changed from the active voice to the passive voice.

Kernel: *The city sponsored the parade.*

Passive: *The parade was sponsored by the city.*

2. All patterns may be transformed into emphatic and negative statements.

Kernel: *She lives nearby.*

Emphatic: *She does live nearby.*

Negative: *She does not live nearby.*

3. All patterns may be transformed into various questions.

Kernels: *They picked berries.*

They were picking berries.

Yes-and-no question: *Did they pick strawberries?*

Information question: *When did they pick strawberries?*

Intonation question: *They picked strawberries?*

4. Many patterns may be changed into imperative statements.

Kernel: *You compared the two boats.*

Imperative: *Compare the two boats.*

5. Many patterns may be transformed into exclamatory statements.

Kernel: *We were happy.*

Exclamatory: *How happy we were!*

6. All patterns may be changed into subordinate structures of different kinds.

Kernels: *Paul was a good captain.*

Paul sailed to Spain.

Subordination: *Paul, who was a good captain, sailed to Easter Island.*

Paul, a good captain, sailed to Spain.

As Paul was a good captain, he sailed to Spain.

7. Most patterns may be transformed into statements introduced by *there* or *it*.

Kernels: *Seven versions of that song are known.*

The song is well known.

There transformation: *There are seven known versions of that song.*

It transformation: *It is true that the song is well known.*

8. Many patterns may be compressed into modifiers.

Kernel: *The cherries tasted sweet.*

Modification: *The sweet-tasting cherries . . .*

9. Many patterns may be combined to form compound structures.

Kernels: *My glasses fell.*

My glasses broke.

Combination: *My glasses fell and broke.*

10. The parts of many patterns may be transposed to other positions in the sentence.

Kernel: *He kept down the price.*

Transposition: *He kept the price down.*

Sentence fragments are common, especially in speech. Sentence fragments appear after many questions. For example, the question *Where were you?* could be answered by the phrase *At the beach*. The answer is a sentence fragment that stands for the complete sentence (*I was*) *at the beach*.

See also **Grammar**; **Parsing**; **Syntax**.

Sentence is a penalty a person must pay if convicted in court of committing a crime. The sentence is normally determined by a judge, but in some countries a jury may decide or recommend a particular sentence. Sentences for some crimes are fixed by law.

In most countries, convicted criminals may be (1) sent to prison; (2) made to pay a fine; or (3) placed on probation or supervision. Sometimes a person may be required to pay a fine as well as serve another sentence. In some countries, there are other forms of sentence such as execution or corporal punishment.

For most crimes a maximum prison sentence is prescribed by law. The actual sentence will depend on whether the convicted person has offended before, and the seriousness of the crime. In many countries, the sentence for murder is fixed by law as life imprisonment. However, because of the *parole* system some murderers are released after a number of years (see **Parole**). The judge may recommend the minimum number of years a murderer should serve in prison.

A person who has committed more than one crime may be sentenced to more than one term of imprisonment. The sentences may run *concurrently* or *consecutively*. If the sentences are concurrent, the prisoner will only serve the amount of the longest term. If the sentences are consecutive, the terms are added together and the prisoner serves the whole amount. Short prison

sentences are sometimes *suspended*, and the convicted person does not go to prison. But if a person with a suspended sentence offends again, the sentence comes into force and an additional sentence may be given for the second crime. In the late 1980's, some countries introduced a system of electronic tagging to restrict offenders to their homes, instead of giving them a prison sentence.

A fine is a sum of money to be paid to the court by someone breaking a law. It is used for less serious offences and in cases where a person has made financial gain out of crime. The money paid as a fine goes to the court, and is not compensation to a person who has lost money or suffered damage. The court may order fines to be paid in instalments over a specified period.

Probation or supervision sentences mean that a person agrees to certain conditions, and reports regularly to a probation officer or social worker. The convicted person receives help and advice to prevent him or her from getting into further trouble and is kept under control of the court.

Other sentences can range from execution, corporal punishment, or mutilation to community service and conditional discharges. Juvenile offenders are not normally sent to prison but may be kept in other forms of custody or may be put under the control of a local authority.

Sentences have several purposes. For example, a sentence puts a criminal in prison to prevent the person from hurting others. Some law enforcement experts believe sentences *deter* (discourage) crime by showing a potential criminal the result of breaking the law. Many people think the main purpose should be to punish criminals. They also believe the harshness of a sentence should depend on the seriousness of the crime. Others believe sentences should *rehabilitate* criminals—that is, change them into law-abiding citizens.

See also **Capital punishment**; **Fine**; **Parole**; **Prison**; **Probation**.

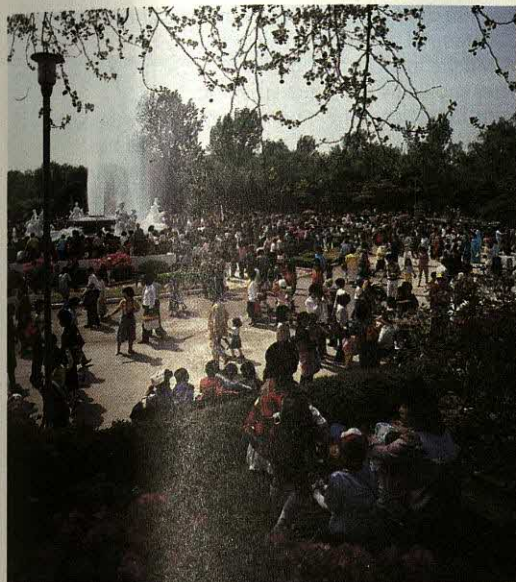
Seoul (pop. 9,645,932), is the capital and largest city of South Korea. Seoul is one of the largest cities in the world in population (see **City**). Seoul serves as the centre of South Korea's cultural, economic, educational, financial, governmental, and political activities.

Seoul is located in northwestern South Korea, about 32 kilometres east of the Yellow Sea. The Han River flows through the city. Since the mid-1900's, Seoul has expanded rapidly. As a result, modern skyscrapers tower above beautiful old palaces and pavilions.

Seoul was founded in 1394 as the capital of the kingdom of *Choson* (the name for Korea at that time). The city's name means *capital*.

The city. Seoul was originally established north of the Han River, in a small valley almost completely surrounded by mountains. The high peaks provided a natural barrier against enemies. During the city's construction in the 1390's, a wall of granite and earth was built around the city. Some parts of this wall still stand. Five gates from the wall, including the South Gate and the East Gate, also remain.

Seoul features a fascinating blend of ancient structures and modern buildings. Several old palaces, preserved in their original form, are now open to the public as museums. They house art objects collected through-



Children's Park, north of the Han River, is one of many parks and recreational areas in Seoul. *Above*, visitors gather in the park on Children's Day, a holiday celebrated each spring.

out Korea. One of the best-preserved palaces, the Changdok Palace, originates from 1405. It has an adjoining garden called the Secret Garden, which features lovely wooded areas, ponds, and pavilions. Many government buildings stand near the Changdok Palace.

Other historic royal residences in central Seoul include the Kyongbok Palace and the Toksu Palace. The Chongmyo Royal Shrine, originally built in 1395, lies southeast of the Changdok Palace. The shrine was built by Yi Songgye, the king who founded Seoul, as a memorial to his ancestors.

Modern skyscrapers housing businesses and hotels lie north of the river. Many marketplaces and shops are also in the central area. Itaewon is a popular shopping area among tourists. Discount houses concentrated in this section offer a wide selection of items produced in South Korea.

During the 1900's, Seoul expanded to include the plain south of the Han River. About 20 bridges cross the river. Many apartment buildings, factories, office buildings, restaurants, stores, and theatres lie south of the river. Such modern sports facilities as the Seoul Sports Complex, Olympic Stadium, and Olympic Park—used for the 1988 Summer Olympic Games—are also in this area.

Facts in brief about Seoul

Population: 9,645,932.

Area: 627 km².

Climate: Average temperature—January, -4 °C; July, 25 °C. Average annual precipitation (rainfall, melted snow, and other forms of moisture)—125 cm.

Government: Special city (same administrative status as a province); under direct supervision of the Office of Prime Minister.

Founded: 1394.

South Korea's legislature meets at the National Assembly building on Youido Island in the Han River. South Korea's tallest building, the 63-storey Daehan Life Insurance Building, also rises on the island.

Seoul has many theatres that offer a variety of cultural events. The National Theatre is the home of the National Ballet Company, the National Drama Company, the National Opera Company, and the National Symphony Company. The theatre stands north of the river, in Namsan Park. The Sejong Cultural Centre, near the Kyongbok Palace, hosts musical and dance performances.

Seoul has 20 universities. Seoul National University, the best-known institution of higher learning in South Korea, lies at the southern edge of the city. Many other universities, including Yonsei University, are north of the river.

People. Almost all of Seoul's people are Korean and speak the Korean language. The Chinese constitute the largest minority group in Seoul.

Until recent times, most of Seoul's people lived in houses near the Changdok Palace. However, the expansion of the city and the improvement of transportation changed the residential pattern in Seoul. Today, more than half of Seoul's residents live south of the river. Most people live in apartments. Modern high-rise apartment buildings in the newer areas of the city attract many wealthy residents.

The rapid growth of Seoul since the 1960's created a number of problems common to most metropolitan areas. The population increase has led to a housing shortage, in spite of the construction of new apartment buildings and the development of suburban areas. Traffic congestion persists, and air pollution and water pollution pose serious problems. Seoul's crime rate has also risen.

Economy. Seoul is the centre of banking, commerce, and industry in South Korea. Most of the country's banks and businesses have their headquarters in Seoul and employ many of the city's people. Other residents work for the national government or for the city's numerous schools.

Seoul's factories produce a variety of consumer products and employ a large number of workers. Chief products manufactured in the city include cars, clothing, electronics, iron and steel, radios, and television sets. Many of these products are exported.

Seoul's people usually shop at huge markets located throughout the city. The biggest markets—Tongdaemun (East Gate) Market and Namdaemun (South Gate) Market—offer all kinds of food and other goods. Different areas in Seoul's markets may specialize in one type of goods, such as clothing or antiques. Department stores are also scattered throughout the city.

Railways, roads, and airlines connect Seoul with cities in the eastern and southern parts of South Korea. Seoul's Kimpo International Airport handles international flights. The city's underground railway system provides transportation. Cars, buses, and taxis crowd the city's streets. Incheon, about 32 kilometres southwest of the city centre, is Seoul's seaport.

About 20 daily newspapers are published in Seoul and distributed throughout South Korea, as are popular monthly and weekly magazines. National TV and radio programmes are produced in Seoul.



A bustling shopping district in Seoul attracts crowds of customers and passers-by. Seoul is South Korea's most densely populated city.

Government. Seoul is divided into 22 local government units called *gu* (wards or districts) each of which is divided into subdistricts called *dong*. The government of South Korea appoints the chiefs of the 22 districts and the mayor of the city. The people of Seoul elect a City Assembly of 130 members. The City Assembly makes the city's laws.

History. Archaeological remains indicate that people lived on the northern shore of the Han River near

present-day Seoul thousands of years ago. In 1067, King Munjong of the Koryo *dynasty* (family of rulers) designated the town as Namgyong (Southern Capital). It was later known by the name Hanyang.

In 1392, General Yi Songgye overthrew the Koryo dynasty and seized the throne. Yi founded the Yi dynasty, who became rulers of what is now Korea. He made Hanyang the capital of his kingdom. The construction of Seoul began in 1394. In 1396, about 200,000 workers were brought to Seoul to build the wall around the city.

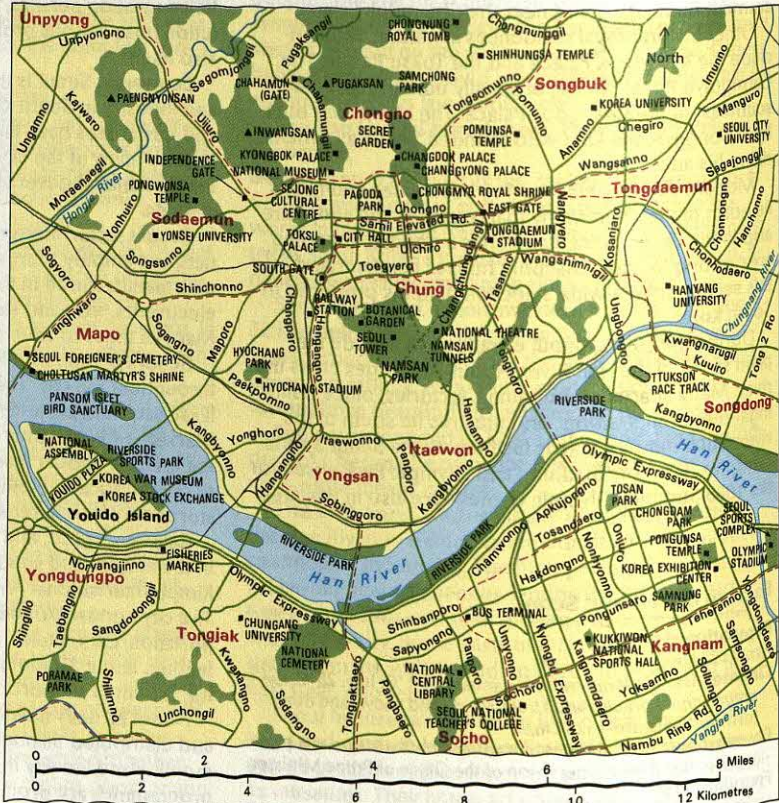
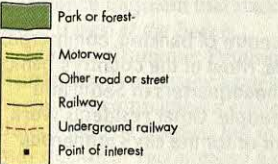
Various Yi kings built palaces and other buildings in Seoul, and the city prospered. But an invasion by the Japanese in 1592 completely destroyed the city. In 1636, Chinese invaders ravaged Seoul. But the city was rebuilt after these invasions, and its population increased.

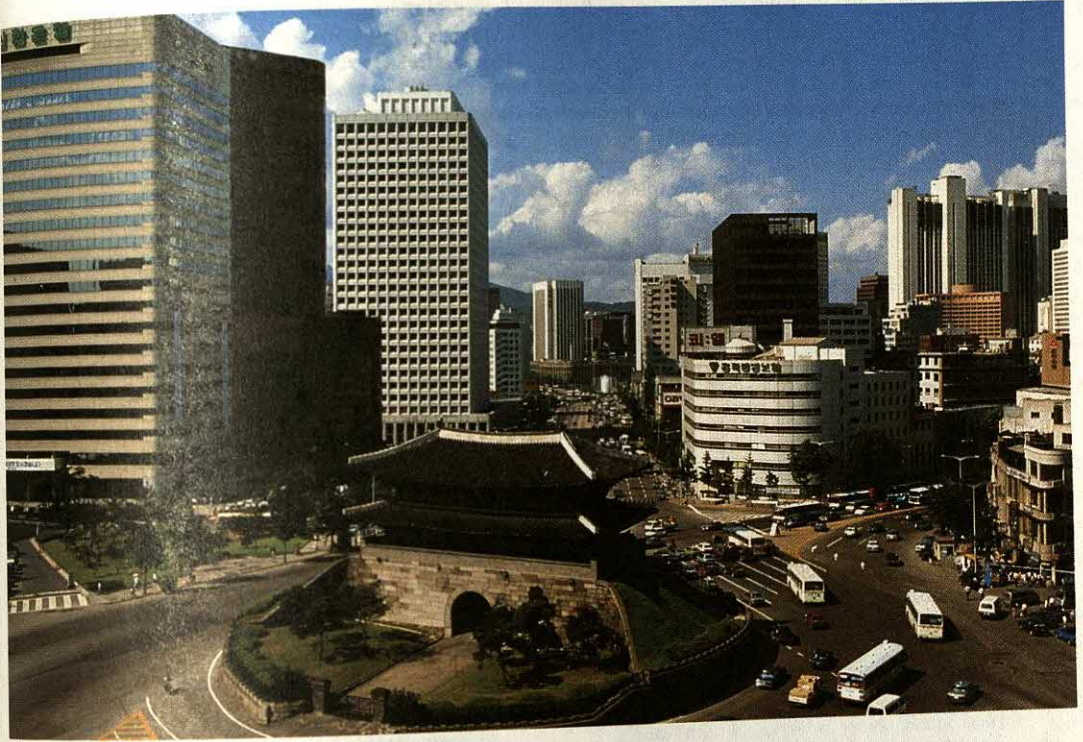
Many important changes took place in Seoul beginning in the late 1800's. Telegraph service began in 1885, with lines between Seoul and Inchon. Schools patterned after those in the West opened in 1886. Missionaries also established schools around that time.

In addition, Seoul's first modern newspaper was published in 1896. Electric trams began to operate in the city in 1899, and in 1902, the first long-distance telephone line in Korea linked Seoul and Inchon.

Japan exerted increasingly strong political and military influence in the area during the late 1800's and the early 1900's. The Yi dynasty continued to rule Korea until 1910, when Japan annexed it as a colony. Seoul became the seat of the Japanese governor general. The Japanese put up many modern buildings throughout the city.

Seoul





Seoul's South Gate dates from the city's founding in the late 1300's. Most of the modern buildings rising in the background have been erected since the Korean War ended in 1953.

These buildings included the Seoul Railway Station and the Governor General's Building, a huge and imposing stone structure that symbolized Japanese power.

The Japanese ruled Korea until 1945, when Japan was defeated in World War II. Korea then was divided. The armed forces of the Soviet Union ran the northern half. The United States military ruled the southern half, with headquarters at the Governor General's Building.

In 1948, the two separate governments of North Korea and South Korea were formed. Seoul was the capital of South Korea and Pyongyang became the capital of North Korea. The South Korean government also used the Governor General's Building as its headquarters. The building is now the National Museum.

The Korean War began in 1950, when North Korean troops invaded South Korea in an attempt to unify the country under Communist rule. Seoul fell to the North Korean Army in June 1950. South Korean and U.S. soldiers recovered the city in September, but they lost it to the Chinese and North Korean armies in January 1951. The South Korean Army regained control of Seoul a few months later. But repeated battles inside the city had destroyed many of the buildings. The war ended in 1953. The people of Seoul rebuilt the city.

Park Chung Hee controlled the South Korean government from 1961 until his death in 1979. Under Park, South Korea experienced tremendous economic growth. Park's economic programmes called for the development of industries in various parts of the country, including Seoul. Until that time, Seoul had no major industry. Many new factories were built in Seoul during the 1960's and 1970's, and thousands of people moved

there from rural areas to find work. Housing construction also boomed. New stores and restaurants opened, and various corporations built office buildings.

When the industrial and residential areas of Seoul became too crowded, construction of new factories and houses spread south of the Han River. The 1988 Summer Olympic Games were held in Seoul. New sports facilities, including a stadium that seats about 100,000 people, were built for the games.

See also *Inchon; Korea* (pictures).

Seow Yit Kin (1955-), a Singapore musician, became the youngest competitor to win the British Broadcasting Corporation piano competition at the age of 19. He went on to perform outstanding solos with internationally famous orchestras. In 1980, he played in concert with the violinist Sir Yehudi Menuhin in the Grand Teton Festival in the United States.

Seow Yit Kin was born in Singapore. He began taking formal piano lessons at the age of 5. Before he was 10, he had passed his grade 8 music examinations with distinction. By the age of 12, he had obtained his Licentiate Diploma of the Royal School of Music. He began violin lessons at the age of 12.

Separatists. See *Pilgrim Fathers; Puritans.*

Separator. See *Butter* (History).

Sepik is a river in New Guinea that rises in the Victor Emanuel Range near the West Irian border. It flows north and east for about 1,130 kilometres to the northern coast near the Schouten Islands. It is bordered mainly by swamps.

Sepiolite. See *Meerschmutter.*

Sepoy Rebellion. See *Indian Revolt.*

September is the ninth month of the year, according to the Gregorian calendar, which is used in almost all the world today. It was the seventh month in the old Roman calendar, and its name comes from the Latin *septem*, meaning *seven*. September later became the ninth month when the ancient Romans moved the beginning of their year from March 1 to January 1. September has had 29 days, 31 days, and, since the time of the Roman emperor Augustus, 30 days.

Activities. Summer ends and autumn begins at the autumnal equinox, on September 22 or 23 in the northern half of the world. There may be hot days during September, but nights are likely to be cool. September is harvesttime in many countries. It was called the harvest month in Switzerland. The Anglo-Saxons called it the barley month. In the Southern Hemisphere, September

is a springtime month, marking the end of winter.

Special days. Many peoples have celebrated harvest festivals in September. In many European countries, the people held feasts and games. The ancient Greeks honoured Demeter, the goddess of agriculture, during this month, and the ancient Romans honoured their goddess of agriculture, whom they called Ceres.

Five Jewish holidays are celebrated in September or early October. They are Rosh Ha-Shanah, or New Year; Tzom Gedaliah, a fast day; Yom Kippur, the Day of Atonement; Sukkot, the Feast of Tabernacles; and Simhat Torah, a day of rejoicing.

September is a month of significance to Hindus in India and other countries

Hindus begin the 10-day celebration of Durga Puja, or the Festival of the Divine Mother, in September.

Important September events

- 1 Canadian provinces of Alberta and Saskatchewan established, 1905.
 - German troops invaded Poland, starting World War II in Europe, 1939.
- 2 Great fire of London began, 1666.
 - Queen Liliuokalani of Hawaii born 1838.
 - Japan's surrender in World War II first celebrated as Victory over Japan (V-J) Day, 1945.
- 3 Great Britain signed Treaty of Paris, ending the Revolutionary War in America, 1783.
 - Louis Sullivan, American architect, born 1856.
 - Sir Frank Macfarlane Burnet, Australian doctor and expert on virus disease, born 1899.
- 4 François René de Chateaubriand, French author, born 1768.
- 5 First American Continental Congress assembled in Philadelphia, 1774.
 - Jesse James, American desperado, born 1847.
- 6 Massachusetts Bay Colony in America established, 1628.
 - Marquis de Lafayette, French statesman, born 1757.
 - John Dalton, English scientist, born 1766.
 - U.S. President McKinley shot by an assassin, 1901.
- 7 Queen Elizabeth I of England born 1533.
 - John McDouall Stuart, explorer of Australia, born in Scotland, 1815.
 - Brazil proclaimed its independence, 1822.
 - Blitz of London in World War II began, 1940.
- 8 First permanent European settlement in what is now America founded in St. Augustine, Florida, U.S.A., 1565.
 - Antonín Dvořák, Czech composer, born 1841.
 - Italy announced its surrender in World War II, 1943.
- 9 Cardinal Richelieu, French statesman, born 1585.
 - Luigi Galvani, Italian anatomist, born 1737.
 - William Bligh, English navigator and captain of the *Bounty*, born 1754.
 - John Gorton, Australian prime minister, born 1911.
- 10 Thomas Sydenham, English doctor, born 1624.
 - Mungo Park, Scottish explorer of Africa, born 1771.
 - Elias Howe patented his sewing machine, 1846.
- 11 William Porter, American short-story writer who used the pseudonym O. Henry, born 1862.
 - Chile's military leaders overthrew elected government of Salvador Allende, 1973.
- 12 English navigator Henry Hudson entered the river named after him, 1609.
 - Russians launched first rocket to the moon, 1959.
 - Emperor Haile Selassie I of Ethiopia overthrown after 58 years as that country's ruler, 1975.
- 13 Walter Reed, U.S. surgeon, born 1851.
 - John Pershing, U.S. general, born 1860.
 - Composer Arnold Schoenberg born 1874.
 - German attack on Stalingrad began, 1942.
- 14 Great Britain adopted the Gregorian calendar, 1752.
 - Alexander von Humboldt, German scientist and geographer, born 1769.
- 15 Novelist James Fenimore Cooper born 1789.
 - Mexico's War of Independence began, 1810.
 - Porfirio Diaz, president of Mexico, born 1830.
 - Orchestra conductor Bruno Walter born 1876.
 - British Army became the first to use tanks in battle, 1916.
- 16 Pilgrims sailed from England to America in the *Mayflower*, 1620.
 - Malaysia came into existence, 1963.
- 17 Constitution of the United States signed, 1787.
 - Friedrich Wilhelm von Steuben, German soldier in the American Revolution, born 1730.
 - Constitution Day and Citizenship Day in the U.S.
- 18 Samuel Johnson, English author and dictionary maker, born 1709.
 - Quebec surrendered to the British, 1759.
 - Chile declared its independence from Spain, 1810.



Sept. birthstone—sapphire



Sept. 1—Start of World War II



Sept. 2—Great Fire of London



Sept. 7—Queen Elizabeth I born

Citizenship Day and Constitution Day are observed in the United States on September 17. Americans also have a public holiday in September, Labor Day, which comes on the first monday of the month. Mexicans and many Mexican Americans celebrate Mexico's Independence Days on September 15 and 16.

September symbols. September's flower is the morning-glory. Sapphire is the gem.

Quotations

By all these lovely tokens
September days are here,
With summer's best of weather
And autumn's best of cheer.

Helen Hunt Jackson

The morrow was a bright September morn;
The earth was beautiful as if newborn;
There was nameless splendor everywhere,
That wild exhilaration in the air,
Which makes the passers in the city street
Congratulate each other as they meet.

Henry Wadsworth Longfellow

Just after the death of the flowers,
And before they are buried in snow,
There comes a festival season
When Nature is all aglow.

Author Unknown

Related articles in *World Book* include:

Calendar
Harvest moon
Rosh Ha-Shanah

Sapphire
Sukkot
Yom Kippur

Important September events

- 18 Jean Foucault, French physicist, born 1819.
—Site of Auckland, New Zealand, purchased from Maoris, 1840.
—John George Diefenbaker, prime minister of Canada, born 1895.
—Japanese forces invaded Manchuria, 1931.
- 19 Edward, the Black Prince, won Battle of Poitiers, 1356.
—Battle of Saratoga in the American Revolution began, 1777.
—Lajos Kossuth, Hungarian patriot, born 1802.
—U.S. President James A. Garfield died of assassin's shot, 1881.
- 20 Sister Elizabeth Kenny, Australian nurse who developed a method of treating poliomyelitis, born 1886.
- 21 Girolamo Savonarola, Italian reformer, born 1452.
—John Loudon McAdam, Scottish road builder, born 1756.
- 22 Earl of Chesterfield, English statesman and author, born 1694.
—Michael Faraday, English scientist, born 1791.
—U.S. President Abraham Lincoln issued preliminary Emancipation Proclamation, declaring freedom for slaves in the republic, 1862.
- 23 Augustus, first Roman emperor, born 63 B.C.
—U.S. sailor, John Paul Jones, commanding the *Bonhomme Richard*, defeated the British ship *Serapis* in the American Revolution, 1779.
—Johann Gottfried Galle discovered the planet Neptune, 1846.
—Howard Florey, Australian scientist and co-discoverer of penicillin, born 1898.
—Sir John Robert Kerr, governor-general of Australia, born 1914.
—The George Cross medal was instituted, 1940.
—Juan Peron re-elected as president of Argentina, 1973.
- 24 Horace Walpole, English author, born 1717.
- 24 First flight by a powered airship by Henri Giffard of France, 1852.
—F. Scott Fitzgerald, American writer, born 1896.
- 25 Columbus sailed on second voyage to America, 1493.
—Spanish explorer Vasco Núñez de Balboa sighted the Pacific Ocean, 1513.
—Billy (William Morris) Hughes, Australian politician, born 1862.
—William Faulkner, American novelist, born 1897.
—Dimitri Shostakovich, Russian composer, born 1906.
—Robert Muldoon, New Zealand Prime minister, born 1921.
- 26 Francis Drake, English sea captain, returned home after circumnavigating the world, 1580.
—William Hobson, first governor of New Zealand, born in Ireland, 1793.
—T. S. Eliot, American-born poet, born 1888.
—George Gershwin, American composer, born 1898.
- 27 George Cruikshank, English caricaturist, born 1792.
—Louis Botha, first prime minister of South Africa, born 1862.
—The British ocean liner *Queen Elizabeth* launched at Glasgow, 1938.
—Germany, Italy, and Japan signed a mutual military aid pact, 1940.
- 28 William the Conqueror and his Norman army landed in England, 1066.
—Georges Clemenceau, French statesman, born 1841.
- 29 Robert Clive, British soldier and founder of British rule in India, born 1725.
—Horatio Nelson, British naval hero, born 1758.
—Miguel de Unamuno, Spanish philosopher, born 1864.
—Nuclear physicist Enrico Fermi born 1901.
- 30 Pompey, Roman general, born 106 B.C.
—First flight by a rocket-powered aircraft, designed by German engineer Fritz von Opel, 1929.



Sept. 15—First use of tanks in war



Sept. 16—*Mayflower* sailed from England



Sept. 28—Normans invade England



Sept. 29—Horatio Nelson born

Septic tank. See *Sewage* (Rural sewage systems).

Septicaemia. See *Blood poisoning*.

Septuagint is the name of the oldest known written translation of the Hebrew Bible, called the Old Testament in Christianity. The Septuagint is a translation from Hebrew into Greek. The name *septuagint* comes from a Latin word meaning *seventy*. According to legend, 70 Jewish scholars translated the first five books of the Hebrew Bible, known as the *Pentateuch*, in 70 days. The translation process began in Alexandria, Egypt, in the 200's B.C. and eventually included other sections of the Bible. The translation actually took about 200 years to complete.

The Septuagint has certain characteristics of style, vocabulary, and order that indicate its translators based some parts on a Hebrew text that differed from the main sources for the Hebrew Bible used today.

Septum. See *Heart* (Parts of the heart); *Nose*.

Sequoia is a tree that ranks among the largest and oldest living things on earth. Millions of years ago these trees grew in large forests throughout much of the world. There were many different kinds. But only two kinds of the true sequoias remain, along with a Chinese tree that is closely related to them. Both kinds of true sequoias, the redwood and the giant sequoia, are found chiefly in California, U.S.A. The name *sequoia* comes from that of a Cherokee Indian who invented a written alphabet for his tribe.

The redwood

Redwoods, also called *coast* and *California redwoods*, grow in the mountains on the Pacific Coast from central California into southern Oregon. The trees thrive there in the relatively warm, moist climate.

Redwoods are the tallest living trees. They grow over 90 metres high, or about as high as a 30-storey building. Their lowest branches may be more than 45 metres from the ground. Many redwood trunks are over 3 metres in diameter.

The redwood's bark is from 15 to 30 centimetres thick and is deeply furrowed. It ranges in colour from red-brown to cinnamon-brown. The wood of the tree is a light clear red. When it is exposed to the weather, it turns dark red. It is durable, and is valued as timber. A single tree may give as much as 1,130 cubic metres of timber. See *Redwood*.

The giant sequoia

The giant sequoia is sometimes called the *big tree* or *Sierra redwood*. It grows only on the western slopes of the Sierra Nevada mountains of California at elevations from 1,500 to 2,400 metres.

The giant sequoias were once distributed over most of the Northern Hemisphere. They now grow in only about 70 groves.

Size. Giant sequoias do not grow as tall as redwoods. But their trunks are much larger. Several of them are about 30 metres around at the base. The diameter of the widest trunk is about 5 metres. The world's largest tree in volume of wood is the General Sherman Tree, in Sequoia National Park. It is just under 84 metres high, and the base of its trunk has a circumference of over 30 metres. It has been estimated that this tree would yield over 1,400 cubic metres of timber. Another of the largest



The world's largest tree, according to volume of wood, is the General Sherman Tree, *above*, in Sequoia National Park in California, U.S.A. This giant sequoia ranks as one of the oldest living things on the earth. It is between 2,200 and 2,500 years old.

giant sequoias is the Grizzly Giant in the Mariposa Grove in Yosemite National Park.

The wood of giant sequoias is extremely brittle and therefore of little use as timber. In addition, because of the great size of giant sequoias, it is not practical to chop them down.

Age. Scientists can tell much about a tree's history and age by looking at the *growth rings*. Each year the tree forms a new layer of wood just inside the bark. The number of rings that make up the trunk show how old the tree is. Sometimes the climate during the year is also shown by the growth ring. Wide rings show when the growing season was good, while narrow rings show when the season was poor. Sometimes lack of rain or moisture will cause a poor growing season. See Tree (illustration: How a tree reveals its history).

Many of the giant sequoias are several thousand years old. It has been estimated that the General Sherman Tree is between 2,200 and 2,500 years old. Before a law was passed that protected sequoias from being cut, one of the oldest and largest of them was chopped down. By counting its rings, it was found that this giant sequoia dated back to 1305 B.C. It was more than a thousand years old at the time of the birth of Christ.

Habits. The giant sequoia is an evergreen with small scalelike needles. They lie more or less parallel to the twig, except for the tip, which is sharp and stands out. The cone is woody and oval-shaped. It grows about 5 to 8 centimetres long. Each cone contains numerous small seeds, which take two years to mature. The seeds of the giant sequoia are only 6 millimetres long.

The giant sequoias are very durable. None of these trees has been known to die from old age, disease, or insect attack. However, lightning has destroyed the tops of most of the largest sequoia trees.

The dawn redwood

The dawn redwood is the only known close relative of the sequoias. Scientists once believed that the dawn redwood had become extinct 20 million years ago. They studied the tree and knew about it only from fossil remains. But in 1941, a Chinese forester, Tsou Kan, discovered a large tree growing in a hidden valley of central China. In 1946, two Chinese botanists, Hsen-Hsu Hu and Wan-Chun Cheng, identified this tree as the dawn redwood. Thus it was discovered that a tree, believed to have become extinct 20 million years before, was still growing in several areas. Living dawn redwoods have since been found in Sichuan and Hubei provinces of China. Fossils show that it once grew in North America as far south as California, and in Greenland, Siberia, and Japan.

The true sequoias are evergreen. But the dawn redwood is *deciduous*, shedding its leaves every autumn and growing new ones in the spring. The dawn redwood bears its cones on long naked stalks instead of needle-bearing twigs or branches. The dawn redwood grows readily from seed, and many have been successfully planted throughout the Pacific Northwest and in southeastern Alaska.

Protection of sequoias

The U.S. government protects most of the country's sequoias. About 8 per cent of sequoias more than 3 me-



A young sequoia, left, has a conelike shape, and its branches reach the ground. The lower branches later drop off, centre, but the cone-shaped crown remains. Most older sequoias lose their tops to lightning and have a rounded crown, right.

tres tall are in private ownership. The government makes strict provision against forest fires and injuries to trees.

Scientific classification. Sequoias belong to the taxodium family, Taxodiaceae. The redwood is *Sequoia sempervirens*. The giant sequoia is classified as *Sequoiadendron giganteum*. The dawn redwood is *Metasequoia glyptostroboides*.

See also **Conifer; Redwood; Tree** (picture).

Sequoyah (1760?-1843), a Cherokee Indian, invented a system of writing for the Cherokee language. He has been called the *Cadmus of America* (see *Cadmus*). The giant sequoia trees and Sequoia National Park in California, U.S.A. are named after him. His name is often spelled *Sequoya*.

Sequoyah was born in eastern Tennessee, U.S.A. His family was highly respected by the Cherokee for its knowledge of tribal traditions and religion. As an adult, he met many white people and became fascinated with their method of communicating by writing. Sequoyah decided to invent a system of writing for his own people. He spent 12 years at this task, which he completed in 1821.

Sequoyah's chief aim was to record ancient tribal culture in a permanent form. The Cherokee also used his system to publish books and newspapers in their own language, and thousands of them learned to read and write the language.

Later, Sequoyah became interested in the general advancement of Indians. He went to Washington, D.C., in 1828 as a representative of the Western tribes. Sequoyah helped settle bitter differences that arose among the Cherokee after the United States government forced them to move to Indian Territory (now Oklahoma) in the 1830's. He died in Mexico while searching for some lost Cherokee.

Serajevo. See Sarajevo.

Serape. See Mexico (Clothing).

Serapis was a god who suddenly became popular in Egypt in the 300's B.C. The Ptolemaic rulers of Egypt, beginning with Ptolemy I in 323 B.C., built an elaborate temple for Serapis and actively promoted his cult throughout the Mediterranean world.

Serapis combined Egyptian and Greek characteristics. In Alexandria, he was portrayed seated on a throne in the pose of a royal figure like Zeus, the king of the Greek gods. Serapis was god of the underworld, associated with Isis, a popular Egyptian goddess. In addition, he provided fertility as the lord of the Nile River. He protected seafarers, inspired oracles, healed the ill, and reigned over the universe like Zeus.

Serapis derived many of his Egyptian characteristics from the cult of Osiris-Apis at Memphis. The name *Serapis* may be a combination of Osiris and Apis. Osiris, the husband of Isis, was a fertility god and god of the underworld. Apis was the earthly form of Osiris in the figure of a bull.

Serbia is one of the two republics of Yugoslavia. Montenegro is the other. In 1918, Serbia became part of the Kingdom of the Serbs, Croats, and Slovenes, later renamed Yugoslavia. In 1946, Yugoslavia became a federal state made up of six republics, the largest of which was Serbia. In 1991 and 1992, four of the republics—Slovenia, Croatia, Macedonia, and the republic of Bosnia-Herzegovina—declared their independence. In April 1992, Serbia and Montenegro formed a new, smaller Yugoslavia.

Serbia covers about 88,361 square kilometres in southeastern Europe. About 9½ million people live in Serbia. Belgrade, the republic's largest city, is the capital of Yugoslavia. It has a population of about 1½ million.

Serbia includes the provinces of Kosovo and Vojvodina, which formerly had special powers of self-government. Each of these two provinces has a population of about 2 million. The capital of Kosovo is Priština. Vojvodina's capital is Novi Sad. Both provinces have residents who are not ethnic Serbs.

Government. A president heads the government of Serbia. The voters elect the president to a four-year term. This official may not serve more than two terms. A one-house National Assembly is Serbia's legislative body. Its 250 members are elected by the people to four-year terms. All citizens who are 18 years and older may vote.

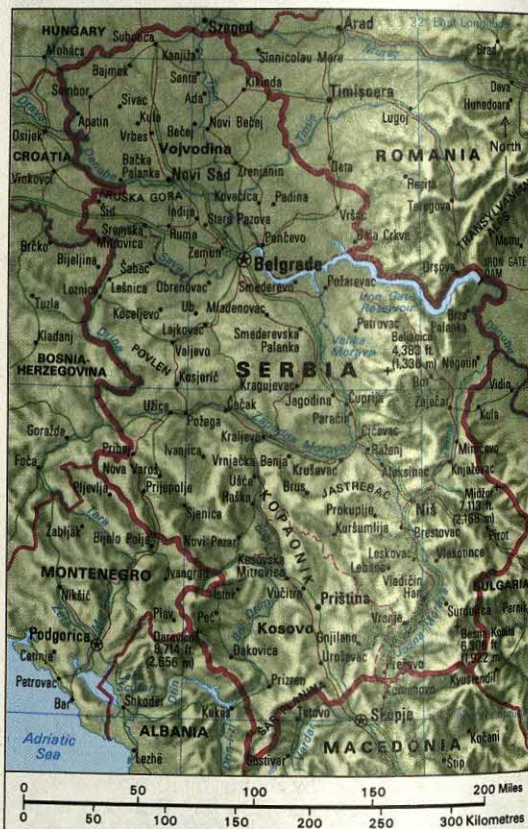
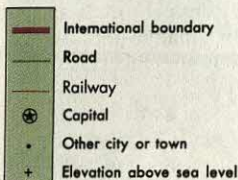
In 1990, Serbia's Assembly approved a new constitution. The Constitution promises freedom of travel, press, and religion, as well as other civil rights. Yet the government still controls much of the press in Serbia, and censorship is tight.

The major political parties in Serbia are the Socialist Party of Serbia (formerly the League of Communists of Serbia), the Democratic Movement of Serbia, and the Serbian Radical Party.

The Court of the Republic of Serbia is Serbia's highest court. The Assembly appoints judges for life.

People. About 65 per cent of the population of Serbia are Serbs. In Kosovo, about 90 per cent of the people are Albanians and the rest are mainly Serbs. About 55 per cent of Vojvodina's population are Serbs and nearly 20 per cent are Hungarians. The province also includes large numbers of Croats, Montenegrins, Romanians, and Slovaks. In the area excluding Kosovo and

Serbia



Serbia is one of the two republics of Yugoslavia. The other is Montenegro. Serbia lies on the Balkan Peninsula of Europe.

Vojvodina—sometimes called Serbia proper—Serbs make up about 85 per cent of the population.

Serbo-Croatian is the official language of Serbia. Serbo-Croatian exists in two main forms, Serbian and Croatian. Serbian, which is spoken by the Serbs, traditionally uses the Cyrillic alphabet, the same system of writing used in Russian. Croatian, which is spoken by the Croats, uses the Roman alphabet. However, many Serbian books were published in the Roman alphabet during Josip Broz Tito's rule of Yugoslavia from 1945 to 1980. Tito sought to unify the various nationality groups in Yugoslavia by promoting use of a single alphabet.

About half of the people of all of Serbia live in cities. About one-third of the population of Kosovo live in cities. The rest make their homes in small villages. In Vojvodina, more than half of the people live in cities.



Belgrade, Serbia, is the capital and largest city of Yugoslavia. It lies in northern Serbia. The city centre includes a pedestrian-only shopping area, left.

Many rural families in Serbia live in brick, stone, or wooden houses with steep roofs. Typical suburban housing consists of high-rise apartment buildings made of concrete. Most city dwellers live in older brick houses or apartment buildings.

Serbian cooking reflects both central European and Turkish influences. *Čevapčići*, which consists of grilled meatballs served with raw onions on bread, is a Serbian speciality. *Ajvar* is a relish made of roasted red peppers. A favourite snack in Serbia is *burek*, a pastry layered with cheese, meat, or jam. Typical Serbian beverages include thick, sweet Turkish coffee and plum brandy.

Serbians enjoy many sports, particularly soccer. Since the 1970's, basketball has gained greatly in popularity. Almost every town or village in Serbia has its own basketball team.

The traditional religion of the Serbs is Serbian Orthodoxy. Some Serbs are members of the Seventh-day Adventist Church. Hungarians and Slovaks typically belong to such "ethnic churches" as the Hungarian Evangelical Lutheran Church or the Slovak Evangelical Christian Church. Most Albanians in Kosovo are Muslims.

Children in Serbia must complete at least 8 years of primary school. However, most children attend school for 12 years. Serbia has universities in Belgrade, Novi Sad, and Priština.

Most of the adults in the urban areas of Serbia are well-educated. However, in rural Serbia, especially among Albanian Muslims, families have traditionally kept girls out of school to work around the house or on the farm. This practice has kept many rural women in domestic roles.

Serbian folk music is played mainly on the accordion. The violin and the *tamboura*, an instrument resembling a lute, are also used to accompany folk dances in certain

parts of Serbia. The best-known traditional dance among the Serbs is the *kolo*, which is performed in a circle.

Since the early 1980's, a new, sometimes extreme, pride in Serbian culture has swept the republic. This movement has sparked an interest in Serbian writers of the 1900's, such as Matija Bećković, Miloš Crnjanski, Dobrica Ćosić, and Vuk Drašković.

Land and climate. The Pannonian Plains lie in northern Serbia. The region is mostly flat, with some low hills. The rest of Serbia is hilly or mountainous.

A number of rivers flow through Serbia. They include the Danube, one of the longest waterways in Europe. The Danube flows southeast to the Black Sea. The Morava River runs north through the hills of southern and central Serbia and then empties into the Danube. The Sava River flows eastward, emptying into the Danube at Belgrade.

The Pannonian Plains have cold winters with a freezing wind called a *košava*. Summers are dry and hot, with temperatures often rising to about 38 °C. In Belgrade, on the edge of the Pannonian Plains, the average January temperature is 0 °C. The average July temperature is 23 °C. The rest of Serbia has bitterly cold winters with much snow. Heavy rains fall in early summer. Summers are warm in the mountain valleys but cool at higher elevations.

Economy. After World War II (1939-1945), the economies of Serbia proper and Vojvodina grew steadily until the late 1970's, when they began to decline. In Kosovo, the standard of living began at a much lower point and has continued to drop. The Serbian economy has suffered greatly since the breakup of the old Yugoslavia.

Serbia's best farmland lies in Vojvodina and in Šumadija, an area south of Belgrade. Farmers grow



Rich farmland covers much of Serbia. Farmers grow a variety of crops. About half of the people of Serbia live in rural areas.

maize, potatoes, sugar beet, and wheat. They also rear cattle, pigs, and sheep. Factories in Serbia produce cars, cement, iron and steel, plastics, textiles, and trucks. Serbia has deposits of coal, copper, lead, and zinc.

A good network of roads extends from Belgrade, but the rest of Serbia has fewer roads. Roads between some villages are unpaved. Railways link Belgrade with major cities and towns in Serbia and in neighbouring countries. Serbia has airports in Belgrade, Niš, and Priština. The Belgrade airport is the largest and handles international flights.

The leading daily newspapers in Serbia are *Večernje novosti*, *Politika ekspres*, *Politika*, and *Sport*, all published in Belgrade; and *Dnevnik*, published in Novi Sad.

History. During the A.D. 500's and 600's, various groups of Slavs, including the ancestors of the Serbs, settled in the Balkan Peninsula in the area of present-day Serbia. Each group had its own leader until the late 1100's, when Stefan Nemanja, a warrior and chief, formed the first united Serbian state. During the 1300's, Emperor Stefan Dušan led the country in successful wars against the Byzantine Empire. The Serbian empire began to break up after his death in 1355. The Ottoman Empire, based in what is now Turkey, conquered Serbia in the Battle of Kosovo Polje in 1389.

The Ottoman Empire ruled Serbia for more than 400 years, but the Serbs never lost their national pride. Djordje Petrović, a Serbian peasant who was nicknamed Black George, led an uprising against the Ottomans in 1804. Another Serbian peasant leader, Miloš Obrenović, led a second revolt in 1815. The Serbs won some liberties in these struggles. Serbia regained independence only in 1878, following the Ottoman Empire's defeat by Russia in the Russo-Turkish War of 1877-1878. In the First Balkan Wars (1912-1913), Serbia and the other Balkan states gained control of almost all of the Ottoman Empire's territory in Europe.

During the early 1900's, various economic and political conflicts developed between Serbia and Austria-Hungary. In June 1914, the heir to the throne of Austria-Hungary, Archduke Francis Ferdinand, was assassinated by Gavrilo Princip, a Serbian patriot from the province of Bosnia-Herzegovina in Austria-Hungary. The assassination touched off World War I, which began a month

later when Austria-Hungary declared war on Serbia. After the war ended in 1918, Serbia led the way in forming the Kingdom of the Serbs, Croats, and Slovenes. The kingdom was renamed the Kingdom of Yugoslavia in 1929.

During World War II (1939-1945), the Axis powers—led by Germany and Italy—occupied Yugoslavia. After the war, a group of Communists led by Josip Broz Tito founded Yugoslavia with a federal system of government. Serbia became one of the country's six republics.

Differences between ethnic groups have often led to protests and violence in Serbia. Ethnic Albanians, who make up about 90 per cent of Kosovo's population, have protested against Serbian rule of the province and demanded greater independence.

In 1987, Slobodan Milošević, a strong supporter of Serbian unity and the expansion of Serbia's borders, became chief of the League of Communists of Serbia. In 1989, Milošević became president of the republic. Under his leadership, Serbia gradually stripped Kosovo and Vojvodina of their *autonomy* (self-rule). In 1990, Serbia dissolved Kosovo's government. Albanians in Kosovo voted for independence in a *referendum* (direct vote) held in 1991. In May 1992, they elected a new president and parliament in an effort to move toward self-government. Serbia declared the referendum and the elections illegal.

The Communist Party gave up its monopoly on power in Yugoslavia in 1990. Multiparty elections were held in Serbia that year, and Milošević was reelected president. The League of Communists of Serbia, which changed its name to the Socialist Party of Serbia (SPS), gained control of the legislature. Opposition groups protested against the continued rule of former Communists in Serbia.

Serbia always had more influence than any other republic in Yugoslavia's federal government. Other republics, especially Croatia and Slovenia, complained of this influence. In June 1991, Croatia and Slovenia declared their independence, and Yugoslavia began to break apart. Serbs living in Croatia, supported by the Yugoslav military, fought against the Croats. In January 1992, the United Nations (UN) helped establish a cease-fire. More than 14,000 UN peacekeeping troops were sent to Croatia. However, scattered fighting continued.

In March 1992, the republic of Bosnia-Herzegovina (commonly called Bosnia) declared its independence. Fighting then broke out in Bosnia, pitting ethnic Serbs, who opposed independence, against Bosnian Muslims and Croats. By the end of 1992, Serbian forces held about 70 per cent of the country. Tens of thousands of people had died, and about two million—most belonging to Bosnia's Muslim ethnic group—had been forced from their homes. Witnesses also charged the Serbs with torturing ethnic Croats and Muslims held in detention camps and massacring Croat and Muslim villagers.

In April 1992, Serbia and Montenegro formed a new Yugoslavia. In May, the UN imposed an oil and trade embargo against Yugoslavia in an attempt to end the fighting in Bosnia-Herzegovina. Despite growing dissatisfaction with Milošević, he was reelected president in December 1992.

The UN trade embargo, coupled with inflation of approximately 2,000 per cent a year, had brought Serbia's

economy near to collapse by March 1993. Food shortages led to rioting in Belgrade. The government introduced rationing of certain basic food items.

In April 1993, the International Court of Justice called on Serbia to prevent acts of genocide in Bosnia. Later that month, Serbia's parliament endorsed the Vance-Owen plan, a peace initiative for Bosnia sponsored by the UN and the European Community (now the European Union). But fighting in Bosnia continued.

In parliamentary elections in December 1993, Milošević's party (SPS) failed to retain a majority of seats. However, in February 1994, members of an opposition party joined the SPS to form a majority in parliament.

In July 1994, the Yugoslavian government announced that it would cut off most of its support to the Bosnian Serbs. The government also accepted the presence of international observers on the Bosnian border to ensure enforcement of the weapons blockade. In response to this, the UN voted to lift temporarily some of its sanctions against Yugoslavia. In 1995, despite further attempts at negotiation, fighting continued in Bosnia.

See also **Belgrade; Bosnia-Herzegovina; Yugoslavia.**
Serenade is a musical composition that has both instrumental and vocal forms. The instrumental form is more important in music history. It consists of a collection of many short *movements* (sections) written for a small group of stringed instruments, wind instruments, or both. The movements may include marches and minuets. Instrumental serenades developed as a form in the late 1700's.

Traditionally, a vocal serenade is the song a lover performs beneath his lady's window at night. The term comes from the Italian word *sera*, which means *evening*. While he sings, the lover usually accompanies himself with an instrument he can carry, such as a guitar. Wolfgang Amadeus Mozart wrote a famous serenade, "Deh vieni alla finestra," in his opera *Don Giovanni* (1787).

Serf was a member of a large class of peasants that developed in the early Middle Ages mainly in Europe. The term *serf* comes from a Latin word that means *slave*. The status of a serf was midway between that of a free person and a slave. Serfs were generally bound to the soil—that is, they were part of a lord's property and were not allowed to leave without the lord's permission. They also had to provide certain payments and services to their lord. In these respects, serfs were not free. But by custom, serfs enjoyed certain rights of which they could not be justly deprived. See **Manorialism**.

A serf's holdings usually included a crude house, the adjoining plot of ground, a share of surrounding fields, and a few animals. Part of the serf's crop went to the lord as rent. The serf was also obligated to work on the lord's land and made special payments to him.

In the later Middle Ages, the rise of towns and changes in population weakened the manorial system and serfdom gradually declined. English law ended serfdom in the 1600's. But Russia and Prussia had serfs until the 1800's.

See also **Russia (History)**.

Serge is a fabric usually made from wool, rayon, cotton, or silk. It has a twill weave, which appears as diagonal or slanting ribs or lines on the surface of the material. Worsted serge is used to make dresses, suits, coats, and caps. Silk serge is used largely for linings.

Sergeant at arms is an officer who keeps order during the meetings of clubs and deliberative bodies. The sergeant at arms also serves legal papers for the assembly. In addition, this officer has the power to compel members to attend sessions when their presence is necessary to make a quorum.

Series, in mathematics, is the sum of the terms of a sequence. For example, the set of numbers 2, 4, 6, 8, 10 form a *sequence*. If you add these numbers, they form the *series* $2 + 4 + 6 + 8 + 10$. A sequence can be any set of *terms* (numbers or algebraic expressions) arranged in a specific order. An example of a sequence with algebraic terms is a, ar, ar^2, ar^3, ar^4 . The related series is $a + ar + ar^2 + ar^3 + ar^4$. A series such as $\frac{1}{2} - \frac{1}{3} + \frac{1}{4} - \frac{1}{5} + \dots$ contains positive and negative terms.

Mathematicians name series in a variety of ways to describe how the terms are formed. They call the series $2 + 4 + 6 + 8 + 10$ an *arithmetic series*. Each term of an arithmetic series is formed by adding a certain quantity to the preceding term. In this example, the quantity added is 2. (The sequence 2, 4, 6, 8, 10 is called an *arithmetic progression*.) The series $a + ar + ar^2 + ar^3 + ar^4$ is an example of a *geometric series*. Each term of such a series is formed by multiplying the preceding term by a certain quantity called the *common ratio*. In this example, the common ratio is r . (The sequence a, ar, ar^2, ar^3, ar^4 is called a *geometric progression*.)

Other common types include power series, trigonometric series, and factorial series. The terms of a *power series* contain some quantity raised to successively higher powers. The simplest power series is $1 + x + x^2 + x^3 + x^4 + x^5$ and so on. The terms of a *trigonometric series* contain such expressions as sines and cosines of angles. A simple *factorial series* has the form $1 + (1 \times 2) + (1 \times 2 \times 3)$ and so on. When written in *factorial notation*, this series appears as follows: $1! + 2! + 3!$.

Series that become important mathematical tools are often named after the individuals who develop them. *Fourier Series* are used in physics in the study of waves. *Taylor Series* contributed to the growth of the branch of mathematics known as calculus.

All series are either *finite* or *infinite*, depending on the number of terms they have. A finite series has a definite number of terms that you can count. For example, the series $2 + 4 + 6 + 8 + 10$ is a finite series because it has only 5 terms. An infinite series goes on indefinitely so that you cannot count the number of terms. For example, the sum of all the numbers used in counting by 2's is an infinite series. It is written:

$$2 + 4 + 6 + 8 + 10 + \dots$$

The dots at the end of the series indicate that there is no "last" term. Instead, an infinite number of terms follow.

Working with finite series

The most common questions asked about a finite series are: (1) What is the value of a certain term? (2) What is the sum of a certain number of terms? For example, suppose you want to find the 7th term in the sequence of odd numbers (1, 3, 5, 7, 9, and so on). You can find the answer by merely writing out the following sequence:

$$1, 3, 5, 7, 9, 11, 13$$

The example shows that the 7th term is 13. In a similar

way, you can find the sum of the first 7 terms in the related series:

$$1 + 3 + 5 + 7 + 9 + 11 + 13 = 49$$

Adding the terms shows that the sum is 49.

You can also use mathematical formulas to find terms and sums of many series. The formulas are especially helpful when you must work with a large number of terms. In the formulas, the letter n usually represents the number of a term. For example, the formula for the n th term (U_n) in the sequence of odd numbers is

$$U_n = 2n - 1$$

Using this formula, you can calculate the 7th term in the sequence as follows:

$$U_7 = (2 \times 7) - 1 = 14 - 1 = 13$$

This is the same answer that you obtain when you write out the sequence of numbers. The mathematical formula for the sum of the first n terms (S_n) of the odd-numbered series is

$$S_n = n^2$$

The sum of the first 7 terms is therefore

$$S_7 = 7^2 = 49$$

Again, your answer agrees with the sum you obtain by adding the terms.

Mathematicians have developed similar formulas for finding terms and sums of many kinds of series. For more information about finding terms and sums of progressions, see the article on **Progression**.

Working with infinite series

Probably the simplest infinite series is a geometric series whose common ratio is less than 1. For example, the following geometric series has a common ratio of $\frac{1}{2}$:

$$1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots$$

How do you find the sum of this series if it has an infinite number of terms? You can start by making a table showing the sum of the first two terms, the first three, the first four, and so on.

Number of Terms (n)	Last Term	Sum of n Terms
1	1	1
2	$\frac{1}{2}$	$1\frac{1}{2}$
3	$\frac{1}{4}$	$1\frac{3}{4}$
4	$\frac{1}{8}$	$1\frac{7}{8}$
10	$\frac{1}{512}$	$1\frac{511}{512}$

The table shows that the sum gets closer to 2 as you add more terms. If you add enough terms, you can make the sum come as close to 2 as you wish. But the sum never reaches 2. The number 2, then, is called the *limit of the sum of n terms as n increases without bound*. You can express this statement with symbols as follows:

$$\text{Limit } S_n = 2$$

$$n \rightarrow \infty$$

The symbols $n \rightarrow \infty$ signify that the number of terms increases without bound. Such a limit may also be called merely the "sum" of the series.

You can use mathematical formulas to prove that the sum of this series is 2. The formula for the sum of n terms (S_n) of any geometric progression is:

$$S_n = \frac{a - ar^n}{1 - r}$$

In this formula, a represents the first term of the series, r the common ratio, and n the number of terms. The expression in the preceding column can also be written as two terms:

$$S_n = \frac{a}{1 - r} - \frac{ar^n}{1 - r}$$

Consider the second term in the above formula. Let the common ratio, r , be any number less than 1. Then, as the number of terms, n , increases without bound, the factor r^n approaches zero. The limit of the second term is therefore zero. (You may want to tabulate some values for the second term to see why this is so. Make r any value less than 1. Then calculate the value of the second term for several increasing values of n .)

The second term of the formula is zero only when n increases without bound. Therefore, we must write:

$$\text{Limit } S_n = \frac{a}{1 - r}$$

$$n \rightarrow \infty$$

To put this formula to work, we merely insert the proper values. In our example, $a = 1$, and $r = \frac{1}{2}$:

$$\text{Limit } S_n = \frac{1}{1 - \frac{1}{2}} = \frac{1}{\frac{1}{2}} = 2$$

$$n \rightarrow \infty$$

The formula shows that the limit of the sum is 2, the same number arrived at when the series of terms was tabulated.

When the sum of a series approaches a limit as the number of terms increases without bound, the series is said to *converge*. Otherwise, the series is said to *diverge*. Mathematicians can prove that many series converge. However, even though convergence can be proved, it is often difficult or impossible to develop a formula for the sum. In such cases, the sum must be obtained approximately by adding terms in the series. In this way, mathematicians calculate many important quantities. These quantities include the trigonometric functions; logarithms; and mathematical constants such as π and e (the base of the natural logarithms).

One of the early expressions for π was developed by the Scottish mathematician James Gregory (1638-1675):

$$\pi = 4(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \dots)$$

The terms of this series form a *harmonic progression*. Gregory's series converges slowly. This means you have to add a large number of terms to extend the accuracy only slightly. Today, mathematicians use other series that converge more rapidly to the value of π . The expression below shows π carried out to 20 decimal places:

$$\pi = 3.14159265358979323846 \dots$$

With rapidly converging series and the aid of high speed computers, mathematicians can obtain a value of π correct to more than 100,000 decimal places.

For the series used to calculate e , see **Logarithms** (Natural logarithms).

Serum is the clear, fluid part of the blood that is left after a clot forms. Serum is just like *plasma* (the total liquid part of the blood) except that serum does not contain *fibrinogen*, a substance that causes clotting.

Serum contains such substances as salt, proteins, glucose, and fats. Samples of serum are used to help *diagnose* (determine) the medical problems of patients. Tests on blood serum are called *serological tests*.

Serum proteins contain *antibodies* that the body produces to fight certain diseases and *toxins* (poisons). A serum containing antibodies that is taken from a person or animal and injected into a patient is called an *antiserum*. Antisera work against such diseases as diphtheria and *tetanus* (lockjaw). *Antitoxins* are certain kinds of antisera.

Serum taken from someone who has recently recovered from a disease usually contains more than the normal amount of antibodies. This serum may help cure or prevent the disease in others. However, doctors have found a more efficient way of providing the antibodies to fight a disease. Instead of using the entire serum, they inject only a part of the serum called *gamma globulin*. Gamma globulin is a kind of protein that contains most of the blood's antibodies. Gamma globulin preparations are used to fight and prevent hepatitis, measles, mumps, and whooping cough.

Serum obtained from animals is easier to obtain and costs less than serum from human beings. But it is often less effective and more dangerous than human serum. A horse is usually used because it has a large amount of blood and produces many antibodies. Horse antisera are used to prevent rabies and to treat people bitten by poisonous snakes and black widow spiders. They are also used to treat *botulism* (food poisoning), gas gangrene, and rabies. However, some patients are *allergic* (extremely sensitive) to animal proteins, and may have serious reactions.

See also **Plasma; Blood transfusion; Antitoxin; Gamma globulin.**

Serval is a large wildcat that lives in Africa, from the Cape of Good Hope north to Senegal and the Sudan. The male is from 90 to 120 centimetres long and stands 45 to 60 centimetres tall at the shoulder. It has a 30-centimetre tail and large ears.



A **serval** is a large wildcat with a head much like that of a domestic cat. A serval has a black-spotted, tawny coat.

Servals are easy to tame if they are captured when young, but they are difficult to raise. They are usually taken in snares. Servals hide in bushes along riverbanks, waiting for their prey. They eat small fowl and other creatures up to the size of small antelope. They generally hunt on the ground, but they also are expert climbers and often go into the trees after birds.

Scientific classification. The serval is a member of the cat family, Felidae. It is *Felis serval*.

Servetus, Michael (1511-1553), was a Spanish doctor and theologian. His description of the pulmonary circulation is considered a classic passage in physiology. He was born in Tudela, Spain, and studied medicine in Paris. He lectured in Paris, and then practised medicine in several French cities. Servetus met with disfavour by both Roman Catholic and Protestant church authorities. John Calvin in particular condemned him for not conforming to accepted doctrines. Servetus was tried, accused of being a heretic, and burned at the stake at Champel in Switzerland.

Service, James (1823-1899), an Australian political leader, became a leader of the federation movement which led to the formation of the Commonwealth of Australia in 1901. Service was premier of Victoria in 1880 and from 1883 to 1886. In 1884, he established the federal council, which he dominated until 1889. He represented Victoria at the London colonial conference in 1887, and at the federal conference at Sydney in 1890. Service was born at Kilwinning, Ayrshire, in Scotland. He emigrated to Melbourne in 1853.

Service, Robert William (1874-1958), was a Canadian poet who wrote lively ballads about frontier life in the Yukon Territory, for which he became known as "the Canadian Kipling". Many of his ballads also describe the beauty of the Yukon.

Service was born in Preston, England, and grew up in Glasgow, Scotland. After working briefly as a bank clerk in Glasgow, he moved to Canada in 1894. Service held various jobs in the Canadian and American West until 1902, when he returned to banking. His position as a bank clerk in Dawson and Whitehorse in the Yukon gave him material for his ballads.

Service's first book of verse, *Songs of a Sourdough* (1907), also published as *The Spell of the Yukon*, was an immediate success. This book included his best-known ballads, "The Shooting of Dan McGrew" and "The Cremation of Sam McGee." These two ballads portray the hardship and violence of life in the Yukon during the gold rush of the late 1890's. Service wrote several other books of verse, including *Ballads of a Cheechako* (1909) and *Rhymes of a Rolling Stone* (1912). Service also wrote six novels, which were not as successful as his ballads. His most popular novel was *The Trail of '98: A Northland Romance* (1911).

Service left the Yukon in 1912 and travelled extensively. In *Rhymes of a Red Cross Man* (1916), he described his experiences as an ambulance driver during World War I. Service spent most of his later life in France.

Selections of Service's verse appear in *Collected Poems of Robert Service* (1944). He also wrote a two-volume autobiography, *Ploughman of the Moon: An Adventure into Memory* (1945) and *Harper of Heaven: A Record of Radiant Living* (1948).

Service industries are the business firms and government and nonprofit organizations that produce services rather than manufactured goods or agricultural products. Services consist mainly of such nonmaterial things as film developing, financial advice, hospital care, and retail sales. Service industries include such broad categories as amusement and recreation, vehicle services, business services, education, health care, and household services.

Since the mid-1900's, service industries have played an increasingly large role in the economy of many industrial nations.

In many such countries, service industries make a major contribution to the country's *gross national product*—the value of goods and services produced. This share may be more than one half. Because service industries depend more on people than machinery for their output, they are extremely important as employers. This is why many poor countries with high unemployment try to develop a tourism industry. Tourism provides many jobs for both educated and less educated people. At the same time, it earns the country foreign currency.

Today the fastest growing service industries include tourism and associated industries such as hotel, restaurants and shopping business; banking and insurance and professional services such as those supplied by computing, accounting and legal experts.

Many economists believe that the growth of service industries represents an advanced stage of national economic development. They say that a nation develops service industries on a large scale only after its agricultural and manufacturing industries have begun to produce on a large scale.

Servo. See **Aeroplane, Model** (Radio control models). **Servomechanism** is a type of control system that detects and corrects errors. Industry uses servomechanisms to control automatic machines. On warships, servomechanisms aim guns, using information received from radar. Servomechanisms are also used to keep guided missiles on course.

In a servomechanism system, a signal from a *controller* is compared to a signal from the controlled mechanism. The difference between the two signals, usually called the *error signal*, is used to operate a *servodevice*. This mechanism moves or changes the controlled device until the difference in signal becomes zero or nearly zero. For example, the automatic pilot used in aeroplanes has a servomechanism that compares the desired course of the aeroplane to the actual course. The error signal represents any difference between the two, and is used to operate the aeroplane's controls until the craft is back on course. When the aeroplane is on course, the error signal is zero. See **Automatic pilot; Gyroscope**.

People also use the principle of the servomechanism in everyday living. For example, the brain of a driver compares the actual position of the car on the road to the desired position. If the car moves off the road, the eye transmits a signal to the brain. The brain compares the desired position to the actual position seen by the eye. It directs the arms to rotate the steering wheel until the car is back on the road.

See also **Automation**.

Sesame is a herb grown in tropical countries. It is grown mainly for the oil obtained from its seeds. It originally grew in Africa or India and is now widely cultivated in China, India, Japan, Mexico, and the United States. An annual, it grows about 60 centimetres high. Its leaves are oblong, and its tiny flowers are pink or white, depending on the variety. Small capsules contain flat seeds that range from white to brown in colour.

The oil obtained from sesame seeds is straw-coloured, and it is similar to olive oil. It is used in salad dressings and in cooking. The seeds have a delicious taste and are used to flavour bread, biscuits, sweets, and other delicacies.

Scientific classification. The sesame plant is in the pedaliaceae family, Pedaliaceae. It is *Sesamum indicum*.



The sesame plant bears capsules that contain seeds.



Painted screen, ink on paper. Freer Gallery of Art, Washington, D.C.

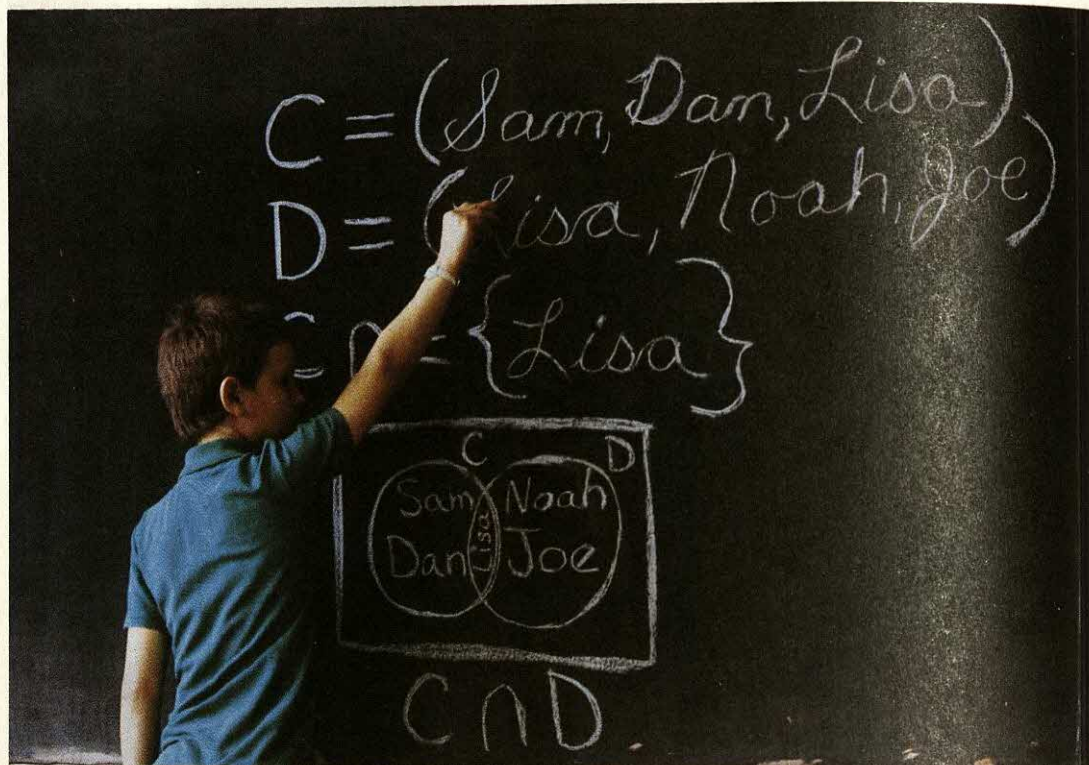
Landscape with Pheasants is one of several screens painted by Sesshu that depict birds amid scenery.

Sesshu (1419-1506), a Buddhist monk, was the greatest Japanese landscape painter in the tradition of Chinese ink drawing. His style is easy to recognize by its bold compositions, forceful drawing, and disregard of subtle modelling. His masterpiece is a long scroll showing Chinese river scenery. Sesshu learned his art by studying the works of Chinese ink masters of the 1200's.

Sessions, Roger (1896-1985), was an American composer and teacher. His compositions are intense, serious, and intellectual. Sessions wrote in the modern 12-tone technique, but he believed a composer should not be limited to one particular musical system. Sessions wrote for orchestra, chamber groups, chorus, solo voice, organ, and piano. He also composed two operas. His most popular work is the orchestral suite *The Black Maskers* (1923). Sessions won the 1982 Pulitzer Prize for music for *Concerto for Orchestra* (1981).

Roger Huntington Sessions was born in New York City. He studied with the Swiss-born composer Ernest Bloch. Sessions wrote *The Musical Experience of Composer, Performer and Listener* (1950) and *Harmonic Practice* (1951). Many of his essays were collected in *Roger Sessions on Music* (1979).

Set. See **Seth**.



Diagrams help solve many problems involving sets. To find out which members of one set are also members of the other set, the student draws a circle around the members of each set. Where the circles overlap, they show who—Lisa, in this case—is a member of both sets.

Set theory

Set theory is a way of solving problems in mathematics and in *logic* (reasoning). By studying set theory, you can get a better understanding of arithmetic and of mathematics as a whole.

Many mathematicians believe that it is possible to derive all of mathematics, including, for example, the theory of functions, from set theory. Therefore, set theory is viewed as one of the most fundamental branches of mathematics.

A *set* is a collection of objects or ideas. A family, a box of crayons, or a flock of sheep is a set of objects. The rules of a game or the even numbers from 10 to 20 are sets of ideas. The items that make up a set are *members* or *elements* of the set. A red crayon is a member of a set of crayons. The number 16 is a member of the set of even numbers from 10 to 20.

Mathematicians use letters to designate sets and the members of sets. Capital letters are used to name sets, and small letters are used to name the members of sets. For example, the letter C may stand for "the set of fifth-form girls with curly hair." The letters m , s , and r would stand for the members of this set—Martha, Sara, and Ruth. To show that set C consists of Martha, Sara, and Ruth, you write: Set $C = \{\text{Martha, Sara, Ruth}\}$ or simply

$C = \{m, s, r\}$. A set is shown by enclosing the members in *braces* $\{\}$.

You may want to show that a member belongs to a certain set. For example, to show that Sara belongs to set C , you write $s \in C$, which is read: " s is a member of C ." If you want to show that Jean is not a member of set C , you would write $j \notin C$, which means: " j is not a member of C ."

A set may also be defined in terms of its properties. A *property* is something that relates the members to one another. In the example above, C has three properties: (1) its members are girls, (2) its members are in the fifth form, and (3) its members have curly hair. To show these properties, you write: $C = \{x | x \text{ is a fifth-form girl with curly hair}\}$. This statement is read: " C is the set of all members, x , such that x is a fifth-form girl with curly hair." The vertical line between the two x 's means "such that."

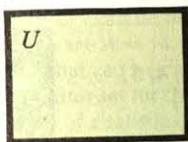
Mathematicians also use various combinations of circles and rectangles to define sets, show relationships, and solve problems. Such drawings are called *Venn diagrams* or *Euler's circles*.

Kinds of sets

In working with set theory, mathematicians compare one set with another. Mathematicians have given names to various kinds of sets to aid in the comparisons. Ten

major kinds of sets are (1) universal, (2) finite, (3) infinite, (4) empty, (5) single element, (6) equivalent, (7) equal, (8) overlapping, (9) disjoint, and (10) subsets. Every set can be called by more than one of these names.

Universal sets consist of all members being considered at any one time. Mathematicians call such a set a *universe* and usually represent it by the letter U . For example, if a certain problem deals with only the whole numbers from 1 to 10, then $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. In another problem, the universe might be all girls in the fifth year or all even numbers. The Venn diagram of the universal set is shown below.



Finite sets and infinite sets. A *finite set* has a definite number of members. "Three cats" and "three thousand head of cattle" are finite sets. An *infinite set* has an endless number of members. For example, the numerals you use in counting form an infinite set. They include 1, 2, 3, 4, 5, and so on without end. It is impossible to list all the members of an infinite set. One way to represent such a set is to list the first few members and then write three dots: $\{1, 2, 3, \dots\}$.

Empty sets, also called *null sets*, have no members. The following sets show which students were absent from school on three days. Monday: Paul, Frances. Tuesday: Joe. Wednesday: No one absent. The Monday set of absentees has two members and the Tuesday set has one member. The Wednesday set has no members; it is an empty set. To show an empty set, leave a blank space between a pair of braces, or write the symbol \emptyset . Thus, students absent on Wednesday = $\{\} = \emptyset$.

Single element sets contain only one member. In the example above, the set of students absent on Tuesday, $\{\text{Joe}\}$, is a single element set.

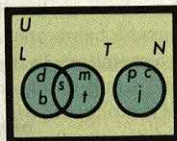
Equivalent sets have the same number of members. For example, if there are four desks and four students in a classroom, the set of desks is equivalent to the set of students. To show that A and B are equivalent, write: $A \leftrightarrow B$. The symbol \leftrightarrow is read: "is equivalent to." If the classroom has five desks and four students, then the sets are not equivalent. To show this, write $A \nleftrightarrow B$, which is read: "A is not equivalent to B."

Equal sets have the same members. Suppose that the set of students who received 100 per cent on a spelling test is $S = \{\text{Pete, Mark, Joan, Tom}\}$. Suppose further that the set of students who received 100 per cent on an arithmetic test is $A = \{\text{Tom, Joan, Pete, Mark}\}$. S is equal to A because the sets have the same members. To indicate that the sets are equal, you would write: $S = A$.

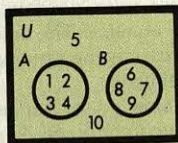
Overlapping sets and disjoint sets. *Overlapping sets* have some members in common. If the set of last year's class prefects is $L = \{\text{Dick, Susan, Betty}\}$ and the set of this year's prefects is $T = \{\text{Mark, Susan, Tom}\}$, sets L and T overlap because Susan belongs to both sets.

Disjoint sets have no members in common. Suppose the set of students appointed prefects next year is $N = \{\text{Patty, Carmen, Jim}\}$. Set N is disjoint from L and T because it does not have any elements in common.

The Venn diagram below shows the relationships between sets L , T , and N .



Subsets are contained within other sets. For example, the set of hockey players with curly hair is a subset of the set of all hockey players. In another example, consider the universe of $\{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. If set $A = \{1, 2, 3, 4\}$ and set $B = \{6, 7, 8, 9\}$, then A and B are subsets of the set U . To show this, you write $A \subset U$ and $B \subset U$. The symbol \subset is read: "is included in." Subsets A and B are finite sets because they have a definite number of members. Subsets A and B are also equivalent sets because they have the same number of mem-



$A \subset U$
 $B \subset U$

bers, and they are disjoint sets because no members belong to both A and B .

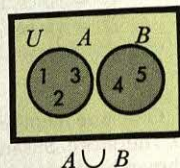
Operations with sets

Three basic operations are used to solve problems involving sets: (1) union, (2) intersection, and (3) complement. These operations resemble arithmetic operations, such as addition and subtraction. In general, you work with two sets at a time, and produce a third set. The terms *union*, *intersection*, and *complement* name the operations and the sets that result from using the operations.

Union of sets includes all members of two sets without repeating any members. The symbol for union is \cup , which is called "cup." To show the union of sets A and B , you write $A \cup B$, which is read: "A union B."

Union of disjoint sets:

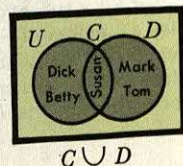
$$\begin{aligned} A &= \{1, 2, 3\} \\ B &= \{4, 5\} \\ A \cup B &= \{1, 2, 3, 4, 5\} \end{aligned}$$



The union of sets A and B includes all the members of A and B . In the Venn diagram, $A \cup B$ is represented by the shaded portions taken together. Note that A has 3 members, and B has 2. So $A \cup B$ has $3 + 2 = 5$ members. In the union of disjoint sets, the number of members equals the sum of the members in the sets.

Union of overlapping sets:

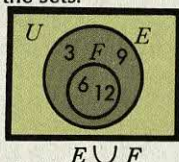
$$\begin{aligned} C &= \{\text{Dick, Betty, Susan}\} \\ D &= \{\text{Susan, Mark, Tom}\} \\ C \cup D &= \{\text{Dick, Betty, Susan, Mark, Tom}\} \end{aligned}$$



The shaded portion of the diagram represents $C \cup D$. If you add the number of members in sets C and D , you get 6. But when you list the members of $C \cup D$, you write Susan's name only once. As a result, set $C \cup D$ has only 5 members. In the union of overlapping sets, the total number of members is always less than the sum of members in the sets.

Union of a set and its subset:

$$\begin{aligned} E &= \{3, 6, 9, 12\} \\ F &= \{6, 12\} \\ E \cup F &= \{3, 6, 9, 12\} \end{aligned}$$



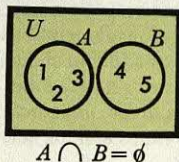
When you list the members of $E \cup F$, you write 6 and 12 only once, because these members belong to both sets. So $E \cup F$ has exactly the same members as E . The shaded portion of the Venn diagram represents $E \cup F$. This portion lies entirely within the circle for E , showing that $E \cup F$ equals E . The union of a set and its subset always has exactly the same total number of members as the set itself.

Intersection of sets is a set that includes only those members that belong to both sets. For example, in the sets $G = \{1, 2, 3\}$ and $H = \{2, 3, 4\}$, the intersection of G and H is the set $\{2, 3\}$. These members belong to both G and H .

The symbol for intersection, \cap , is called "cap." To show the intersection of G and H , you write $G \cap H$, which is read: " G intersect H ."

Intersection of disjoint sets is an empty set:

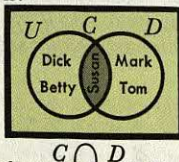
$$\begin{aligned} A &= \{1, 2, 3\} \\ B &= \{4, 5\} \\ A \cap B &= \{\} = \phi \end{aligned}$$



The intersection of A and B is an empty set because the two sets have no members in common.

Intersection of overlapping sets:

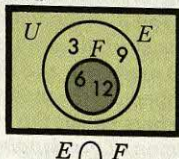
$$\begin{aligned} C &= \{\text{Dick, Betty, Susan}\} \\ D &= \{\text{Susan, Mark, Tom}\} \\ C \cap D &= \{\text{Susan}\} \end{aligned}$$



Only one member—Susan—belongs to both C and D . Therefore, Susan is the intersection of C and D , as shown by the shaded area in the Venn diagram.

Intersection of a set and its subset:

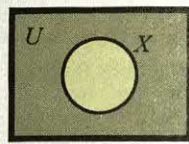
$$\begin{aligned} E &= \{3, 6, 9, 12\} \\ F &= \{6, 12\} \\ E \cap F &= \{6, 12\} \end{aligned}$$



Set F is a subset of E because every member of F is also a member of E . The intersection of E and F is the set $\{6, 12\}$. The shaded portion of the Venn diagram shows $E \cap F$. This portion lies entirely within the circle for F , showing that $E \cap F$ equals F .

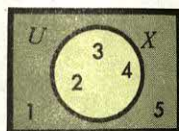
Complement of a set is represented by the shaded portion of the Venn diagram below.

In the diagram, X is a subset of the universal set U .



The shaded portion represents the set of members that belong to U , but not to X . This set is called the complement of X . The symbol X' stands for the complement of X . For example:

$$\begin{aligned} U &= \{1, 2, 3, 4, 5\} \\ X &= \{2, 3, 4\} \\ X' &= \{1, 5\} \end{aligned}$$



The members 1 and 5 belong to U , but not to X . Therefore, the complement of X is $\{1, 5\}$, as shown by the shaded portion of the Venn diagram.

Using set theory

In arithmetic, set theory helps you understand some of the basic ideas of working with numbers. For example, you can learn the meaning of *number* by matching the members of two sets against one another.

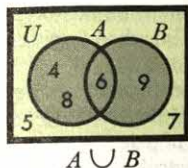
$$\begin{aligned} A &= \{a, b, c, d\} \\ B &= \{e, f, g, h\} \end{aligned}$$

Sets A and B are equivalent. The members are different, but something about the sets is the same. This "something" is the *number* of members in each set. The name you use for any number is called a *numeral*. Thus, the numeral 4 tells you the number of members in either set A or set B . Before ancient people learned to count, they used the idea of equivalent sets to keep track of possessions. See *Numeration systems* (History).

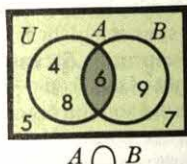
In algebra, sets are helpful in several ways. Suppose that in a certain problem the letter x stands for any number from 1 to 10. You call x a *variable*, and you call the set of numbers from 1 to 10 the *domain of the variable*. The solution of the equation is the set of all numbers in the domain that make a true statement when substituted for x . Such a set is called a *solution set*.

You can use set operations, such as union and intersection, to understand and to solve certain algebra problems. For example, suppose the domain of x is $U = \{4, 5, 6, 7, 8, 9\}$. Find the values of x that satisfy the two conditions: (1) x can be divided evenly by 2, or (2) x can be divided evenly by 3. When two conditions are connected by the word *or*, the solution set must include all values of x that satisfy either the first condition or the second. You find that 4, 6, and 8 can be divided evenly by 2. Therefore, the solution set for the first condition is $A = \{4, 6, 8\}$. You can divide 6 and 9 evenly by 3, so the solution set for the second condition is $B = \{6, 9\}$.

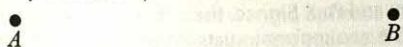
The solution set for the whole problem is $\{4, 6, 8, 9\}$, because each of these numbers satisfies either the first condition or the second. This solution set is the union of the overlapping sets $A = \{4, 6, 8\}$ and $B = \{6, 9\}$.



When two conditions of a problem are connected by the word *and*, the solution set must include all values of x that satisfy both the first condition and the second condition. For example, let $U = \{4, 5, 6, 7, 8, 9\}$. Find the values of x that satisfy the two conditions: (1) x can be divided evenly by 2, and (2) x can be divided evenly by 3. Again, the solution sets are $A = \{4, 6, 8\}$ and $B = \{6, 9\}$. But 6 is the only value that can be divided evenly both by 2 and by 3. The solution set for this problem is $\{6\}$, because only this value of x satisfies both conditions. This solution set is the intersection of the two sets $A = \{4, 6, 8\}$ and $B = \{6, 9\}$, as shown in the following diagram:



In geometry, the sets studied are sets of points. The diagram below shows a set of two points, A and B . Each point is represented by a little dot:

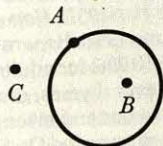


When you connect these two points with a straight line, you form a *line segment*. The notation \overline{AB} is used to represent this segment. Points A and B are the *end points* of the segment. But you can imagine many other points, such as C , D , and E , on the same segment. Thus, segment \overline{AB} consists of points A and B and the set of all points that lie between them.



In a similar way, you can think of the set of all points on a sheet of paper, on a wall, or on any other flat surface. Such a set of points makes up a *plane*. On a plane, you can draw simple *closed curves* by starting at any point and returning to the point without lifting your pencil. Examples of simple closed curves include circles, squares, and triangles. A circle is a closed curve, but a half circle is not.

A closed curve separates a plane into three sets of points: (1) those outside the curve, (2) those inside the curve, and (3) those on the curve itself. The interior of any simple closed curve is called a *region*. The curve is the *boundary* of the region. The region and the boundary are called a *closed region*. In the diagram, point A belongs to the set of points on the boundary, B belongs to the set of points inside the circle, and C belongs to the set of points outside the circle.

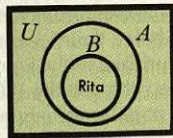


In logic, set theory can help you form conclusions based on statements called *premises*. Here is the way

you would use sets to illustrate a simple logical conclusion. In this example, the universal set is the set of all pupils at your school.

1. *First premise:* All girls in your class are members of the school choir. *Second premise:* Rita is in your class. *Conclusion:* Rita is a member of the school choir.

Let A be the set of members in the school choir, and let B be the set of girls in your class. According to the first premise, B is a subset of A . That is, every member of B is a member of A . According to the second premise, Rita belongs to set B . Therefore, Rita must also belong to set A .



History

The set theory developed from two mathematical discoveries of the 1800's—*symbolic logic* and *the theory of sets*.

Symbolic logic is a way of using mathematical symbols and operations to solve problems in logic. George Boole (1815-1864), an English mathematician, established the basis of this technique in the 1840's.

In the 1870's, the German mathematician Georg Cantor (1845-1918) applied some of the ideas of symbolic logic to sets of numbers. He formed a theory that he called "the theory of sets." Cantor developed this theory because of his interest in infinite quantities. For example, he showed how the members of certain infinite sets could be matched one for one against each other.

In the 1950's and 1960's, mathematicians and educators recognized that the ideas of set theory could help pupils understand the principles of arithmetic and mathematics. The study of sets became a part of what was called the "new mathematics." By studying sets, pupils learned the meaning of such basic ideas as *number* and *numeral*. They also learned to apply mathematics to the field of logic.

Now mathematicians and educators continue to stress the new mathematics. But they also give added emphasis to solving problems and learning basic computational skills.

Related articles in *World Book* include:

Algebra	Logic
Arithmetic	Mathematics
Boolean algebra	New mathematics
Geometry	Numeration systems

Outline

- I. **Kinds of sets**
 - A. Universal sets
 - B. Finite sets and infinite sets
 - C. Empty sets
 - D. Single element sets
- II. **Operations with sets**
 - A. Union of sets
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- III. **Using set theory**
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- E. Equivalent sets
- F. Equal sets
- G. Overlapping sets and disjoint sets
- H. Subsets
- C. Complement of a set
- C. In geometry
- D. In logic

Seth, also called Set, was an ancient Egyptian god of storms, violence, darkness, and desert land. He was also a god of desert animals, serpents, pigs, hippopotamuses, and crocodiles. Seth was identified with an animal that had the body of an elongated jackal or greyhound; a long neck; a thin, curved snout; rectangular, upraised ears; and a stiff, forked tail. Seth was often portrayed as having a human body and the head of this beast.

The Egyptians saw Seth's violent characteristics as potentially beneficial. They believed Seth defended the sun god, Re, during his daily journey across the sky when he was threatened by the dangerous Apophis serpent. Egyptian kings attributed their ferocious warlike power to Seth. His cult flourished in the Egyptian delta where the Hyksos invaders settled in the 1700's B.C. (see Hyksos). Seth was also popular among the pharaohs of Dynasty XIX (about 1291-1183 B.C.).

In the myth of Osiris, Seth appears as the villain. Seth is jealous of Osiris, his brother, who is the reigning king of Egypt. Seth tricks Osiris, kills him, and cuts him into pieces.

See also **Mythology** (Egyptian mythology; picture); **Osiris**.

Seti I (reigned about 1303-1290 B.C.) was a king of ancient Egypt. Early in his reign, he conducted at least two campaigns in Syria in an effort to check the advance of the Hittites and to re-establish the empire of Thutmose III in Palestine and Syria. Seti built the temple of Abydos. He also decorated the walls of the Great Hypostyle Hall (hall of columns) at Karnak, which had been begun by his father Ramses I and which was completed by his son Ramses II. His tomb, the most splendid one in the Valley of the Kings, was discovered in 1817, and his mummy, together with that of Ramses II, was found in 1881, in another tomb near Dayr al Bahri.

Setter is a long-haired hunting dog. It is used to search for such birds as quail and partridge. There are three recognized breeds in the setter family: *English*; *Gordon*; and *Irish*. All have silky coats, expressive eyes, and heavy muzzles. They are intelligent and gentle. The setter was developed from the old "setting spaniel." Setters are about the same size and shape as pointers, but have the spaniel's long hair.

A setter hunts game in the same way that pointers do (see **Pointer**). It ranges the field until it smells game. Then it comes to a *point*, with its nose pointing at the game, its body stiff, and its tail out straight or raised a little. Sometimes it lifts one front paw while pointing. The dog holds its point until the hunter *flushes* the game (makes it move from its hiding place). After the shot, the setter brings back the game.

See also **Dog** (pictures: Sporting dogs); **English setter**; **Gordon setter**; **Irish setter**.

Settlement, Act of, passed in England in 1701, vested the succession to the English crown in Sophia, Electress of Hanover, and her Protestant heirs. Sophia was a granddaughter of James I. The English Parliament passed the Act because William III had no children, and his successor, the future Queen Anne, had lost her only surviving child. Parliament did not want a Roman Catholic on the throne of England, and after Anne's death the strongest claim to the throne would be that of James II's Roman Catholic son, James Edward Stuart. The Act

placed a new royal family on the throne after the death of Queen Anne in 1714, when Sophia's son became King George I.

See also **Jacobite risings**; **Pretenders**.

Seurat, Georges (1859-1891), was a French artist who developed a system of painting called *pointillism*. Instead of using brushstrokes, Seurat painted uniform-sized dots of brilliant colour side by side. Seen from a distance, the dots seem to merge and suggest other equally bright colours. Pointillism resulted in simplified forms to the extent that human figures appear impersonal and robotlike. These qualities appear in Seurat's *Sunday Afternoon on the Island of La Grande Jatte* (1886). This painting is reproduced in the **Painting** article.

Seurat was influenced by the impressionist painters, especially Claude Monet and Camille Pissarro. He used the bright colours of the impressionists and also their subjects—artists' studios, circus scenes, and harbours and seashores. But Seurat rejected the casual, relaxed approach of the impressionists and their attempts to portray what the eye sees at a glance. To find a more controlled, scientific approach, Seurat studied the theories on colour and light of the French chemist Michel-Eugène Chevreul and the French artist Eugène Delacroix (see **Delacroix, Eugène**).

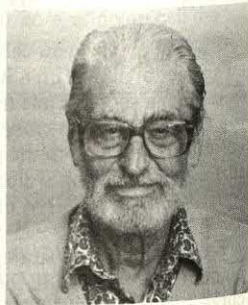
When *La Grande Jatte* appeared in an exhibition of impressionist art in 1886, it attracted several painters to pointillism. As a group, these painters became known as *neoimpressionists*. They included Henri Cross, Camille Pissarro, and Paul Signac, the spokesman of the movement. The neoimpressionists influenced many painters of the early 1900's, including the fauves, the futurists, and the German expressionists.

Seurat was born in Paris. He kept to himself, and few details are known of his personal life. He painted almost constantly but completed few works. Seurat died of diphtheria at the age of 31.

See also **Impressionism** (Postimpressionism).

Seuss, Dr. (1904-1991), was the pen name of Theodor Seuss Geisel, an American writer and illustrator. Dr. Seuss was best known for his books for children. These works combine delightful nonsense and humorous drawings.

Most of Dr. Seuss's books are written in simple verse and are illustrated by him. They include *And to Think That I Saw It on Mulberry Street* (1937), *The 500 Hats of Bartholomew Cubbins* (1938), *How the Grinch Stole Christmas* (1957), *The Cat in the Hat* (1957), *Hop on Pop* (1963), and *The Butter Battle Book* (1984). He wrote and illustrated *You're Only Old Once!* (1986) for adults. Young readers enjoy Dr. Seuss's clever rhymes, drawings of fantastic creatures, and silly names and invented words. In 1984, the Pulitzer Prize Board awarded Dr. Seuss a Special Citation "for his contribution over nearly half a century to the education and enjoyment of America's children and their parents."



Dr. Seuss

Theodor Seuss Geisel was born in Springfield, Massachusetts. He received no formal training in art, and he wrote and illustrated his first book to amuse himself. He also worked as a public relations specialist and as a cartoonist and humorist for magazines and film studios.

Sevastopol (pop. 335,000) lies on the Black Sea, in the southwestern part of the Crimean Peninsula in Ukraine. For location, see Ukraine (map). Sevastopol has a long harbour. The 11-month siege of the city in 1854 and 1855 marked the chief battle of the Crimean War. Sevastopol was attacked again in 1918, during World War I. An eight-month siege in 1941 and 1942, during World War II reduced the city to ruins, but it has been largely rebuilt.

Seven Cities of Cibola. See **Cibola, Seven Cities of.**

Seven seas is an ancient term describing all the seas and oceans of the world. Many people believe the seven seas referred to are the Arctic, Antarctic, North and South Pacific, North and South Atlantic, and Indian oceans. However, the phrase has no literal meaning, and it came into use before some of the oceans were even known to exist.

Seven Sleepers of Ephesus were seven Christian youths in an old legend who were said to have fled to the mountains near Ephesus in Asia Minor to escape the persecution of the Emperor Decius in about A.D. 251. Pursuers discovered their hiding place and blocked the entrance. Two hundred years later, a shepherd stumbled upon the cave and discovered seven youths asleep. When he awakened them, they believed that only a night had passed. One of them went to Ephesus for food and offered to pay for it with coins 200 years old. He was arrested as a thief of hidden treasure. But Emperor Theodosius II believed a miracle had taken place, and led the youth in a triumphant procession to the cave. Later, he had a great church and graveyard built to mark the spot. The seven sleepers lived for only a short time. All died at the same moment, and were buried where they had slept.

In 1928, Franz Miltner, an Austrian archaeologist, found a tomb near Ephesus which shows that the tale of the Seven Sleepers has some basis in fact. Theodosius' ancient church had been covered by other churches, and was discovered only by accident.

The legend of the Seven Sleepers began in Syria and appeared in European literature in the A.D. 500's. The legend was a favourite theme in the art of the Middle Ages, and the story is told in the Quran, the Muslim holy book.

Seven Weeks' War, also called the Austro-Prussian War, took place between June and August of 1866. Austria and most of the German states fought against Prussia and Italy. Otto von Bismarck, prime minister of Prussia, used the war as part of his campaign to force Austria out of the German Confederation and make Prussia the dominant power in Germany.

A dispute over the former Danish duchies of Schleswig and Holstein furnished the immediate cause of the war. Austria, joined by the German states of Hesse, Saxony, and Hanover, declared war on Prussia on June 14, 1866. Bismarck secured the help of Italy. He also helped persuade France to remain neutral by suggesting vaguely that France would be given new territory if Prussia won the war.

The Prussian army was outnumbered. However, it had a brilliant leader in General Helmuth von Moltke. His skilful use of new railways and such new inventions as the fast-firing "needle gun" and the telegraph enabled the Prussians to win a series of quick victories. The greatest of these victories was the crushing defeat of the Austrians at the Battle of Königgrätz (also called Sadowa) on July 3.

The peace treaty ending the war was signed in Prague on August 23. According to the terms of the treaty, Austria had to give Venetia to the new Kingdom of Italy and was also required to pay a small amount of money to Prussia. In addition, Austria was excluded from German affairs, and it was never again a power in Germany. The treaty also dissolved the old German Confederation, and permitted Prussia to organize its own North German Confederation in 1867. Prussia dominated the new confederation. Prussia also annexed Schleswig-Holstein, the German state of Hesse-Kassel, the Kingdom of Hanover, the Duchy of Nassau, and the free city of Frankfurt.

See also **Bismarck, Otto von; Germany** (History [The unification of Germany]); **Moltke, Helmuth Karl von.** **Seven Wonders of the Ancient World** is a listing of notable objects built between about 3000 B.C. and A.D. 476. The practice of listing the seven wonders probably began in ancient Greece. One of the first lists was that drawn up by Antipater of Sidon, a Greek writer who lived in the 100's B.C.

The ancient Romans also listed memorable things that they thought travellers should see on their journeys. Many such lists were made, and they included many different objects. But all the lists of ancient wonders included only objects made by human beings and considered notable because of their great size or some other unusual quality. This article discusses the seven most commonly listed wonders of the ancient world.

The pyramids of Egypt at Giza, built as tombs for Egyptian kings, are the oldest and best preserved of all the ancient wonders. Three famous pyramids there were built between about 2600 and 2500 B.C. The largest pyramid, called the Great Pyramid, stands about 135 metres high. Its base occupies an area of about 5 hectares. The Greeks and Romans marvelled at the size of the pyramids. They were unaware of the religious importance of the pyramids as tombs, and considered them as foolish extravagances on the part of the Egyptian kings. See **Pyramids.**

The Hanging Gardens of Babylon were probably built by King Nebuchadnezzar II for one of his wives. Nebuchadnezzar ruled Babylon from 605 to 562 B.C. Babylon was located near modern Baghdad in Iraq. Scientists have been unable to identify positively the remains of the gardens. Our information about the gardens comes from an account by Berossus, a Babylonian priest of the 200's B.C. Berossus described gardens that were laid out on a brick terrace about 120 metres square and 23 metres above the ground. In order to irrigate the flowers and trees in the gardens, slaves worked in shifts turning screws to lift water from the Euphrates River.

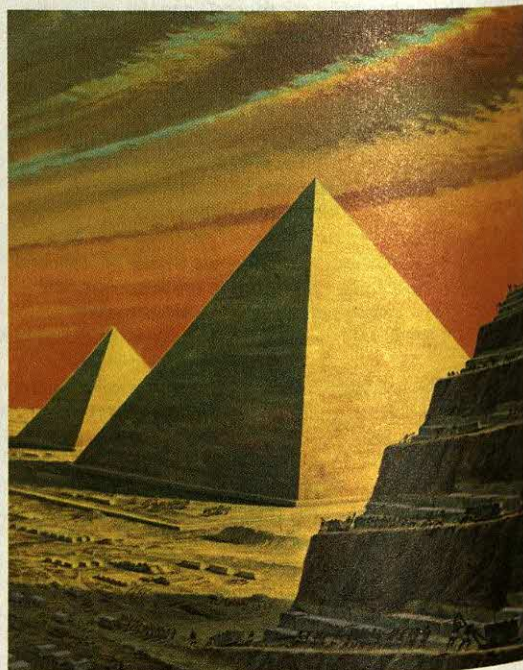
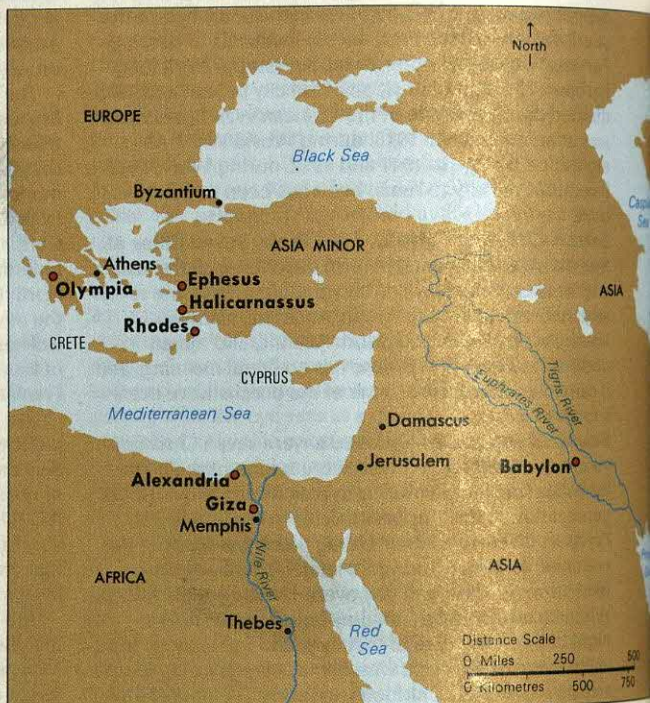
The Temple of Artemis at Ephesus, built about 550 B.C., was one of the largest and most complicated temples built in ancient times. It stood in the Greek city of

Seven Wonders of the Ancient World

Ancient Greeks and Romans made up many lists of notable objects. These illustrations show the objects that have been most commonly listed as the Seven Wonders of the Ancient World. The map, below right, shows the location of the Seven Wonders of the Ancient World in red.



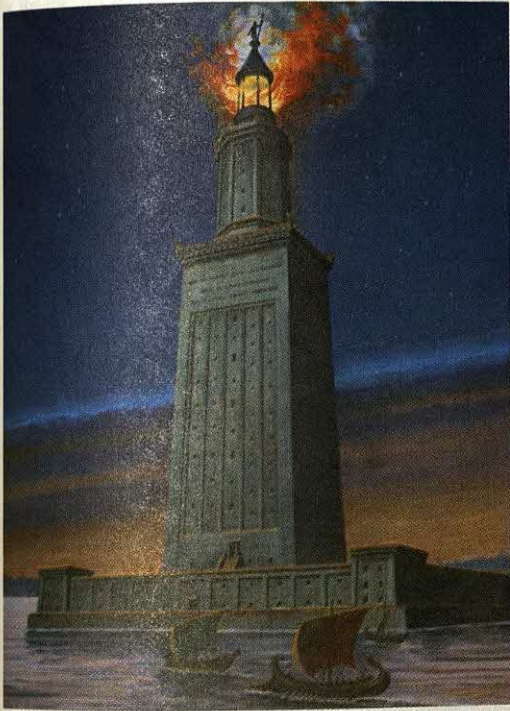
The Temple of Artemis at Ephesus was one of the largest temples built by the Greeks. It was famous for its decoration and extensive use of marble.



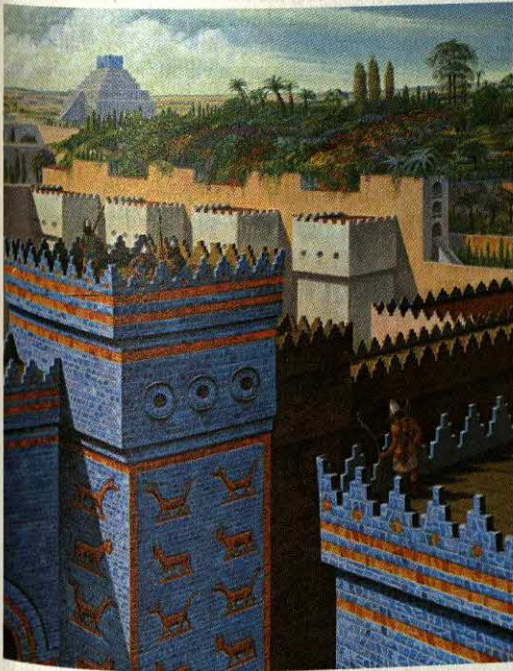
The pyramids of Egypt at Giza are the best preserved of the Seven Wonders of the Ancient World. They still attract many visitors to Giza, just outside the present-day city of Cairo.



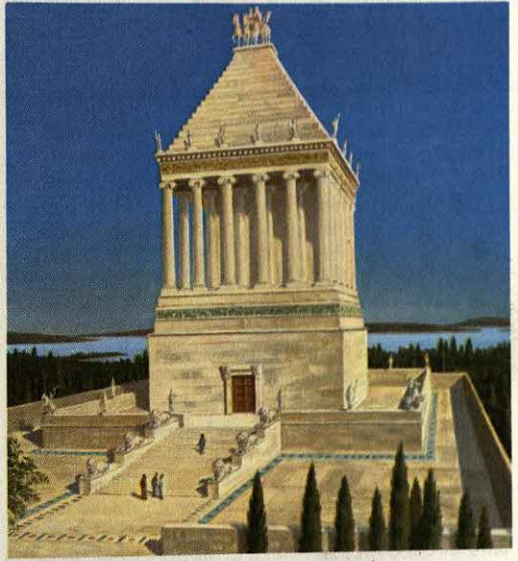
The statue of Zeus at Olympia, Greece, was probably the most famous statue made by the Greeks. People who came to watch the Olympic Games admired this gold and ivory figure.



The **Lighthouse of Alexandria**, Egypt, was the world's first important lighthouse. It guided ships into the city's harbour for about 1,500 years before being toppled by an earthquake.



The **Hanging Gardens of Babylon** probably were built by King Nebuchadnezzar II after he married a mountain princess. He apparently hoped the gardens would make her feel at home.



The **Mausoleum at Halicarnassus** was a great marble tomb. It was built for Mausolus, a local ruler, by some of the most famous Greek sculptors and architects.



The **Colossus of Rhodes** was built in honour of the sun god Helios. It was constructed after the people of Rhodes survived a year-long siege by a large force of Macedonians.

Ephesus, on the west coast of what is now Turkey. The temple was entirely marble, except for its tile-covered wooden roof. It was dedicated to the Greek goddess Artemis and was designed by the architect Chersiphron and his son, Metagenes. Its foundation measured 115 by 55 metres. It had 106 columns, about 12 metres high, in a double row around the *cella* (inner space). Wealthy King Croesus of Lydia donated some of the columns.

The temple burned down in 356 B.C., and another one like it was built on the same foundation. Goths burned down the second temple in A.D. 262. Only the foundation and parts of the second temple remain. The British Museum in London contains sculptures from the second temple.

The statue of Zeus at Olympia, Greece, was perhaps the most famous statue in the ancient world. The Greek sculptor Phidias made it about 435 B.C., and dedicated it to Zeus, the king of the gods. The statue, 12 metres high, showed Zeus on his throne. Phidias made Zeus's robe and ornaments out of gold, and he made the god's flesh of ivory. In the statue, Zeus had a wreath around his head and held a figure of Nike, the goddess of victory who was also his messenger, in his right hand. He held a *sceptre* (king's rod) with an eagle in his left hand. The statue no longer exists. See Phidias.

The Mausoleum at Halicarnassus, in what is now southwestern Turkey, was a huge, white marble tomb. It was built about 353 B.C. to hold the remains of Mausolus, a provincial ruler in the Persian Empire. Its size and decorations made it so famous that all large tombs are now called *mausoleums*. The tomb was about 40 metres high. It had a rectangular basement beneath a colonnade formed by 36 columns. A stepped pyramid rested on the colonnade, and a statue of Mausolus in a chariot probably stood on top of the pyramid. The Greek architects Satyros and Pythios designed the tomb. Four famous Greek sculptors—Bryaxis, Leochares, Scopas, and Timotheus—carved the *frieze* (decorated band) on the building. The top part of the mausoleum was destroyed by an earthquake, and only pieces of the building and its decorations remain. Some of the sculptures from the mausoleum may be seen in the British Museum in London.

The Colossus of Rhodes was a huge bronze statue that stood near the harbour of Rhodes, an island in the Aegean Sea. The statue honoured the sun god Helios. It stood about 37 metres tall—about as high as the Statue of Liberty. The Greek sculptor Chares worked 12 years on it in the early 200's B.C. He used stone blocks and about 6.8 metric tons of iron bars to support the hollow statue. In 224 B.C., the Colossus was destroyed by an earthquake. The metal supports were sold for scrap in A.D. 653.

The Lighthouse of Alexandria, over 122 metres high, stood on the island of Pharos in the harbour of Alexandria, Egypt. It became so famous that the word *pharos* came to mean *lighthouse*. The lighthouse is also called the Pharos of Alexandria. The structure, completed during the reign of Ptolemy II (283–246 B.C.) from a design by the Greek architect Sostratos, rose from a stone platform in three sections. The bottom section of the lighthouse was square, the middle eight-sided, and the top circular. A fire burning at the top of the lighthouse provided light. The Lighthouse of Alexandria

stood for about 1,500 years before it was finally toppled by an earthquake sometime in the A.D. 1300's.

Seven Years' War (1756–1763) involved nearly every nation in Europe, and extended to America and India. In America, it was called the French and Indian War. In Europe, Prussia and Austria fought each other for control of Germany. Great Britain aided Prussia, and France helped Austria. Britain fought France for control of the seas and territories in North America. As a result of the Seven Years' War, France lost its North American empire to Britain.

In Europe. The Seven Years' War resulted from the desire of Maria Theresa, ruler of Austria, to recover possession of the province of Silesia from Frederick the Great, king of Prussia. Frederick had taken most of Silesia from Austria, but Maria Theresa never gave up hope of regaining it. She allied herself with Czarina Elizabeth of Russia, who bitterly hated and feared the Prussian king. Maria Theresa found it more difficult to make an alliance with France, Austria's ancient enemy. She finally succeeded with the aid of her shrewd foreign minister Wenzel Anton von Kaunitz. He was aided by an agreement between Britain and Prussia. This agreement alarmed the French, who saw it as an act of treachery by Frederick the Great, their ally.

Meanwhile, Frederick the Great was carefully watching the moves of his enemies. He was determined to strike the first blow. In August 1756, Frederick invaded the German state of Saxony because it was an ally of Austria, wealthy, and strategically located. Frederick soon forced the entire Saxon army to surrender and took control of the state.

In spite of these gains, Prussia's hopes for victory were dim early in 1757. Austria, France, Russia, Sweden, and most of the German states were united against the Prussian king. Britain, Prussia's only ally, gave little help. But Frederick moved with great vigour and decision. In November 1757, he destroyed the French in a great battle at Rossbach in Saxony. A month later, he defeated the Austrians at Leuthen, in Silesia.

In 1758, William Pitt, Britain's secretary of state, began to give more active aid to Prussia. The British organized a new army, which defeated French forces in several encounters.

But Frederick's resources were limited, and his costly campaigns had weakened Prussia. Prussia was near exhaustion and seemed to face almost certain ruin. But Frederick's enemies failed to develop a joint plan against him. In 1762, Elizabeth of Russia died and was succeeded by Peter III. Peter, an enthusiastic admirer of Frederick, concluded a separate peace with Prussia. This turn of fate saved Frederick.

By terms of the peace signed in Hubertusburg early in 1763, most of Silesia remained under Prussian rule, and other boundaries stayed as they had been before the war. There were no territorial changes in Europe. The Treaty of Paris settled disputes between France, Spain, and Great Britain on Feb. 10, 1763.

In America. One of the most important results of the Seven Years' War took place far from Europe. Britain finally won its long struggle with France for the control of North America. At the end of the Seven Years' War, France gave up almost all its lands in North America to Britain, and also gave up its empire in India.

Related articles in *World Book* include:

Frederick II (of Prussia)
Maria Theresa
Pitt (family)

Pompadour, Marquise de
Silesia

Sevenoaks (pop. 106,100) is a local government district in western Kent, England. Many people who live there travel north into London to work. Towns in the district include Edenbridge, Sevenoaks, and Westerham. The district has a number of historic houses, including Chartwell, former home of Sir Winston Churchill; Hever Castle; Knole; and Penshurst Place.

See also **Kent**.

Seventh-day Adventists are a Christian religious denomination. Adventists believe that Christ will return in person. They also believe that after death only the spirit ascends into heaven. The body will be made anew at the Resurrection, which accompanies Jesus' Second Coming. Adventists observe the Sabbath on Saturday, the seventh day of the week. The denomination has about 6 million members throughout the world.

Adventists originated in the early 1800's, when many people in America and Europe became absorbed in the doctrine of Christ's Second Coming. References in the Bible that seemed to prophesy the time of Christ's coming aroused their interest. Followers of William Miller, an American Baptist minister, predicted a definite time for the coming, but his interpretation proved wrong. One group restudied Bible prophecies. It decided that what had happened was the beginning of the judgment in heaven that is to precede the Second Coming of Christ. This group formed in 1863 as the Seventh-day Adventists.

See also **Adventists**.

Severn, River, the longest river in the United Kingdom, rises in the upland area of Pumlumon (Plynlymon), in central Wales, and flows about 350 kilometres to the Bristol Channel. A tunnel 6 kilometres long carries a railway under the Severn south of Chepstow. A suspension bridge for road traffic opened in 1966. These routes carry passenger and goods traffic to and from South Wales and are shorter than the old routes up river.

Seversky, Alexander Prokofieff de. See **De Seversky, Alexander Prokofieff**.

Seville (pop. 668,356) is one of the leading centres of Spanish art, literature, and education. The city is also called Sevilla. Two of Spain's greatest painters, Diego Velázquez and Bartolomé Murillo, were born in Seville. Two famous operas, *Carmen* and *The Barber of Seville*, have the city as their setting. Legend says that Don Juan lived in Seville (see **Don Juan**). The University of Seville dates back to 1502.

The city lies 97 kilometres northeast of Cádiz on the Guadalquivir River, in an area of sunny vineyards and orange groves (see **Spain** [political map]). A great wall with 64 towers once surrounded the city, and its remains still stand. The Moors lived in Seville for hundreds of years. Moorish influence shows in the city's network of small, shaded streets and in the whitewashed, balconied houses built around handsome courtyards and fountains.

Seville's greatest building is its cathedral, started in 1402 and finished in 1519. It stands on the site of a Moorish mosque, and is one of Europe's largest structures. Only St. Peter's in Rome and the basilica in

Lourdes, France, are larger. Some people think Christopher Columbus was buried in Seville's cathedral. But the Dominican Republic also claims to be the burial place of the famous explorer. Seville's emblem is the *Giralda*, a Muslim minaret that is part of the city's cathedral. The *Giralda* stands over 90 metres high. It was built in the 1100's.

Seville's factories produce cigars, pottery, silks, machinery, chocolate, perfume, and iron products. Canals and the Guadalquivir River make the city an important inland port. Exports include wine, olives and other fruit, and cork, mercury, and wool. The city is the capital of the province of Seville.

In 1992, Seville hosted a world's fair called Expo '92. Held during the 500th anniversary year of Christopher Columbus' first voyage to the New World, the fair had the theme "The Age of Discoveries."

Sèvres, Treaty of. At the close of World War I (1914-1918), the Turkish Ottoman Empire and the Allies signed the Treaty of Sèvres at Sèvres, France. The treaty was signed on August 10, 1920, and marked a low point in Turkish power and history. It provided that Syria, Palestine, and Mesopotamia (now mostly Iraq) would be provisionally recognized as independent states to be advised by mandatory powers.

Under the terms of the treaty, the Ottoman Empire was to give up all its territorial claims in northern Africa, and to cede eastern Thrace to Greece. Smyrna (now Izmir) and the Ionia region were to be under Greek rule for five years. The independence of Armenia was recognized and Armenia received a large part of eastern Turkey. The waters around the Ottoman Empire were to be opened to the vessels of all nations, and the Turkish armed forces were to be reduced to a police force. The Treaty of Sèvres also provided for Turkish finances to be controlled by an Allied commission.

This treaty was signed by the Ottoman government, but it was never ratified by the Turkish nationalists. The Turkish leader, Kemal Atatürk, overthrew the feeble Ottoman government and set up a new, independent Turkey. Ankara was made the new Turkish capital. Kemal Atatürk's government refused to recognize the treaty signed at Sèvres. Turkish forces defeated the Greeks at Afyonkarahisar and Bursa, and later drove the Greeks from Izmir. In 1923, the Turkish government negotiated a new peace treaty with the Allied Powers at Lausanne, Switzerland.

See also **Izmir; Atatürk, Kemal**.

Sewage is water that contains waste matter produced by human beings. It is also called *wastewater*. It contains about a tenth of 1 per cent solid matter. Sewage comes from the sinks and toilets of homes, restaurants, office buildings, and factories. It contains dissolved material that cannot be seen, plus bits of such solid matter as human waste and ground-up rubbish. Some sewage may also contain ground and surface water runoff that occurs after storms or floods. Most sewage also includes harmful chemicals and disease-producing bacteria.

Most sewage eventually flows into lakes, oceans, rivers, or streams. In many Western countries, almost all sewage is treated in some way before it goes into the waterways as a semiclear liquid called *effluent*. Untreated sewage looks and smells foul, and it kills fish and aquatic plants.

Even sewage that has been treated can harm the water in some ways. For example, most methods used to treat sewage convert organic wastes into inorganic compounds called *nitrates*, *phosphates*, and *sulphates*. Some of these compounds may serve as food for algae and cause large growths of these simple aquatic organisms. After the algae die, they decay. The decaying process uses up oxygen. If too much oxygen is used, fish and plants in the water will die.

A system of pipes that carries sewage from houses and other buildings is called a *sanitary sewerage system*. There are two main types of sanitary sewerage systems: (1) urban sewerage systems and (2) rural sewerage systems.

Urban sewerage systems

In a public sewerage system, the largest sewers, called *interceptors*, carry the sewage to a *wastewater treatment plant*. Sewage treatment in most cities involves two main steps, *primary* and *secondary* treatment. Some cities also require a step called *tertiary* (third) treatment.

Primary treatment removes the heaviest solid material from sewage. At a treatment plant, sewage first passes through a screen that traps the largest pieces of matter. It then flows through a *grit chamber*, where heavy inorganic matter, such as sand, settles. The liquid next flows into a large *primary sedimentation tank*. Many suspended solids sink to the bottom of this tank and form a muddy material called *sludge*. Grease floats to the surface, where it is removed by a process called *skimming*. The effluent is then released into waterways.

Primary treatment removes about half the suspended solids and bacteria in sewage. Sometimes a gas called *chlorine* is added after primary or secondary treatment

to kill most of the remaining bacteria. Primary treatment removes about 30 per cent of the organic wastes. When the remaining organic wastes are discharged into waterways, bacteria break them down and thus continue the process of purifying the wastewater. The breaking-down process uses up oxygen in the water. See *Water pollution* (Effects).

Secondary treatment removes from 85 to 90 per cent of the solids and oxygen-consuming wastes remaining in sewage after it has undergone primary treatment. The most common methods of secondary treatment are (1) the activated sludge process and (2) the trickling filtration process.

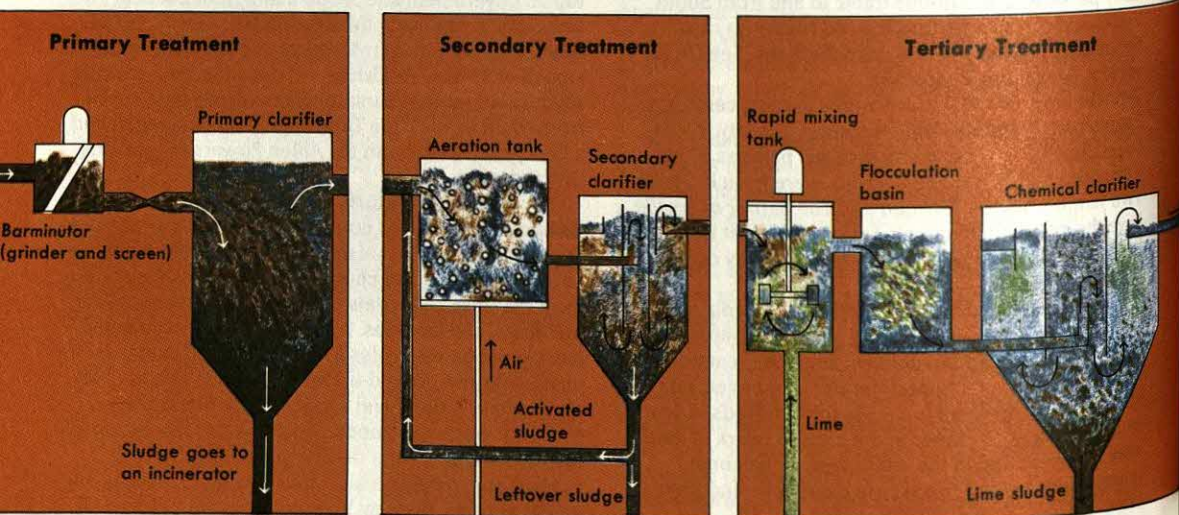
The activated sludge process. In this process, effluent from the primary sedimentation tank flows into a second tank called an *aeration tank*. Air is injected into this tank in a bubbling action. Sludge containing useful bacteria is also in the tank. The useful bacteria move through the liquid and change the organic matter into less harmful substances. Next the liquid flows into a *final sedimentation tank*, where the sludge settles to the bottom. The effluent is then discharged into waterways. Part of the sludge is recycled into the aeration tank.

The trickling filtration process. Trickling filters are tanks filled with crushed rocks. As sewage is distributed over the rocks, it reacts with slime that develops on the rocks. The slime contains useful bacteria that change organic material in the sewage into less harmful substances. These substances are removed in a final sedimentation tank, where they fall to the bottom as sludge.

Sludge resulting from primary and secondary treatment is pumped to a *sludge digestion tank*. In this tank, bacteria break the sludge down into less harmful substances producing methane gas, a useful fuel. Digested sludge may be dried for use as fertilizer or burned.

A modern sewage treatment plant

The modern sewage treatment plant shown in the diagram below provides primary, secondary, and tertiary sewage treatment. The plant uses a method of secondary treatment called the *activated sludge process*.



Primary and secondary treatment remove up to 95 per cent of the waste in sewage. In primary treatment, the largest solids are ground up and settle in a clarifier. In secondary treatment, bacteria further purify the effluent in an aeration tank, and sludge is removed in another tank.

Tertiary treatment removes even more impurities from the effluent. First, the effluent is mixed with lime, which causes particles of matter to *floc* (bunch together) and settle in a clarifier.

Tertiary treatment is used after primary and secondary treatment to produce purer effluent. There are various methods of tertiary treatment. The method a community chooses depends on (1) what substances are present in its raw sewage and (2) how the effluent will be used. Tertiary treatment methods include chemical treatment, microscopic screening, radiation treatment, and discharging the effluent into lagoons.

Tertiary treatment makes effluent safer to discharge into waterways and safer for industry to use.

Rural sewerage systems

Many rural areas are not served by public sewers. In such areas, most homeowners use *septic tanks* to treat their sewage. These tanks are concrete or steel containers buried underground at homes and buildings.

Sewage flows into a septic tank through a pipe connecting the tank with a building. Solids in the sewage sink to the bottom of the tank as sludge or float to the surface as scum. Effluent then flows from the tank into a *leaching field*, a system of pipes with open joints that allows sewage effluent to be gradually distributed into the soil. Soil bacteria then destroy the remaining organic material in the effluent.

In a septic tank, bacteria in the sewage attack and digest the sludge and scum. This *digestion* process changes most of the wastes into gas and a harmless substance called *humus*. The gas escapes into the air. The humus in the tank must be pumped out periodically and taken to a sewage treatment plant.

See also **Plumbing; Water pollution.**

Seward, William Henry (1801-1872), served as United States secretary of state during the American Civil War (1861-1865). He was the leading Republican in the nation in 1860, but Abraham Lincoln defeated him

for the party's nomination. Seward worked for Lincoln's election, and entered his Cabinet as secretary of state. Because of Seward's able administration of foreign affairs, European countries did not aid the Confederacy. He was wounded by an accomplice of John Wilkes Booth on the night that Lincoln was assassinated. He slowly recovered, and continued as secretary of state under President Andrew Johnson.

Among the tasks that Seward accomplished was the purchase of Alaska from Russia. Alaska later proved valuable to the United States, and finally became a state in 1959. But at the time it was mockingly called "Seward's Folly" and "Seward's Ice Box."

Seward was born in Florida, New York, and was educated at Union College in Schenectady, New York. He became a lawyer in 1822, and soon entered politics. Seward won election to the state legislature in 1830 and joined the Whig Party in about 1834. He served as governor of New York from 1839 to 1842 and became a United States senator in 1849. Seward was opposed to slavery, and fought against its spread.

Sewell, Anna (1820-1878), a British author, wrote *Black Beauty* (1877), a novel about a horse that becomes injured and suffers abuse from a series of owners. The book, which became extremely popular, is a moral tale about the cruel treatment of horses. The Society for the Prevention of Cruelty to Animals promoted *Black Beauty*, contributing greatly to the book's success.

Sewell was born in Yarmouth, on the Isle of Wight, England. At the age of 14, she sprained both her ankles. The injury was probably treated incorrectly, and Anna was crippled for the rest of her life. Her greatest mobility was on horseback or in driving a pony and carriage. Sewell was an invalid during the six years she wrote *Black Beauty*, her only book. Her mother, Mary Sewell, a children's author, helped Anna by copying the manuscript.

Sewer. See **Sewage.**

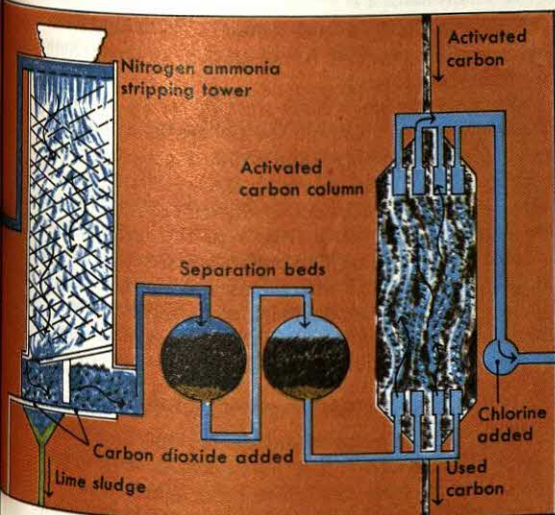
Sewing is the process of attaching pieces of fabric together with a needle and thread. Many people enjoy sewing their own clothes and such household articles as bedspreads, pillows, curtains, and loose covers. Clothing and other items which are sewn at home may be less expensive, wear better, and have more individuality than ready-made products. Sewing also plays a vital role in the clothing, home furnishings, and other industries.

Sewers have a wide choice of fabrics, including cotton, linen, silk, and wool, which are made from plant or animal fibres. Other fabrics consist of manufactured fibres, sometimes called *synthetics*. They include polyester, nylon, and rayon.

People in western Europe and central Asia began to sew, using bone needles, more than 17,000 years ago. Most sewing was done by hand until the 1800's. In 1846, an American inventor named Elias Howe patented the first practical sewing machine. Sewing machines have been greatly improved through the years, and most sewing today is done by machine.

Kinds of stitches

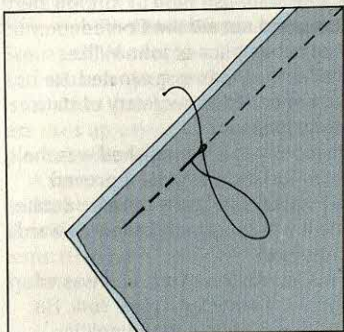
Many kinds of stitches can be used in sewing. The kind used depends on whether the sewing is done by hand or by machine.



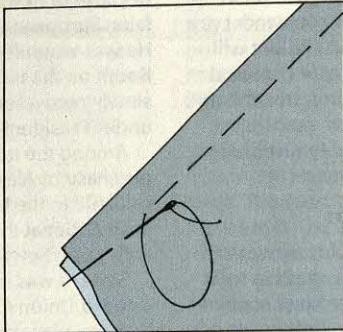
The process continues as the effluent enters a stripping tower, where nitrogen and ammonia are released. The effluent is mixed with carbon, which removes the tiniest bits of organic matter. Finally, chlorine is added to kill most of the bacteria.

Basic kinds of stitches

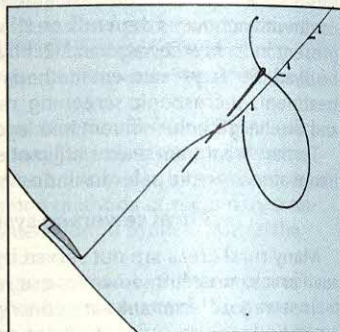
The illustrations below show how to make six basic hand stitches. The light blue areas indicate the right side of the fabric, which lies to the outside of a garment. The wrong side is shaded dark blue.



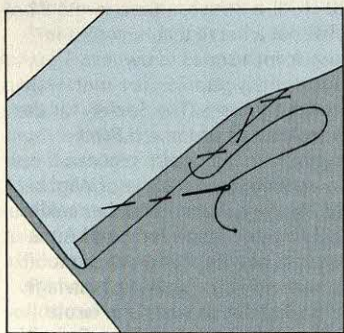
The running stitch is made with small, straight, even stitches. The sewer simply slips the needle over and under through the fabric.



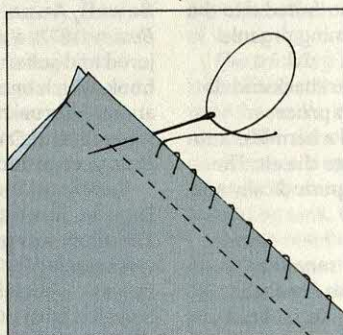
The tacking stitch is made in the same way as the running stitch, but the sewer takes slightly longer stitches. Tacking stitches may be even or uneven.



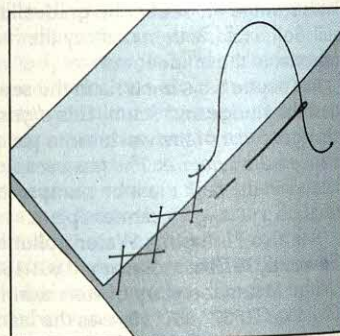
The slipstitch is made by slipping the needle through the fold and taking a tiny stitch in the fabric underneath. The finished stitch is invisible.



The blindstitch is made by taking a small stitch near the edge of the fabric, and then another stitch diagonally below in the fabric underneath.



The overcast stitch is used on the raw (cut) edges of a fabric. The sewer takes slanted, evenly spaced stitches over each of these edges.



The catchstitch is made by taking a small stitch from right to left in the upper layer of fabric, and then a stitch in the layer underneath.

Hand stitches. There are six main hand stitches: (1) the running stitch, (2) the tacking stitch, (3) the slipstitch, (4) the blindstitch, (5) the overcast stitch, and (6) the catchstitch. Illustrations of all these stitches appear above.

The running stitch is the most basic hand stitch. It is used for *gathering*, the process of pulling a piece of fabric together into small folds. These folds, called *gathers*, add fullness to the necklines, sleeves, and waistlines of garments.

The tacking stitch is a temporary stitch that holds two or more pieces of fabric together. Tacking stitches serve as a guide for permanent machine stitching.

The slipstitch provides an invisible finish when permanently attaching flaps, linings, and pockets to a garment. It is used on folded edges because the lengths of thread can be concealed within the folds.

The blindstitch is used to hold hems and *facings* in place. Facings are pieces of fabric that cover edges of a garment. This stitch is used if the sewer does not want the stitches to show.

The overcast stitch is a slanted, evenly spaced stitch used on the raw (cut) edges of a seam. Overcasting prevents the edges from fraying.

The catchstitch is a flexible stitch used to hold two layers of fabric together. It is often used to secure hems in stretchy knit fabrics.

Machine stitches include *straight*, *zigzag*, *utility*, and *decorative* stitches. Straight stitches are used for tacking and gathering and for sewing seams. Zigzag stitches may be used for finishing raw edges, making buttonholes, or attaching elastic to a garment. Utility stitches are used for stretch fabrics like lycra. They are also used for overcasting and making button holes. Machines that make decorative stitches may have special attachments, dials, or levers that set the machine for these stitches. However, most modern machines have simple controls which change the stitch width, length, and pattern.

Preparing for a sewing project

Choosing the pattern and fabric. Only highly experienced sewers design their own patterns. Most people select patterns from catalogues. Most pattern catalogues have a section of easy-to-sew patterns for beginners.

Patterns are sold in envelopes that contain pieces of paper shaped like the various sections of a garment. The sewer uses the pattern pieces to cut the sections from

the fabric. A pattern envelope illustrates all the enclosed pieces. It also suggests suitable fabrics for the item to be sewn and indicates the amount of material required. Necessary items such as buttons, zips, and seam tape are listed by size and number needed. A pattern envelope also contains a layout guide and sewing instructions.

Amateur sewers should avoid fabrics with plaids, stripes, or a *nap*. Napped fabrics have soft, short threads on the surface. Plaid, striped, and napped fabrics require extra skill and time to cut out and sew. The design of plaid or striped fabrics should be matched at the seams. Napped fabrics, such as velvet and corduroy, must be laid out with extra care so that the nap runs in the same direction on all the pieces.

Fitting the pattern. Sometimes several garments can be made from one pattern. The layout guide tells which pieces to use for each garment. The pattern pieces have markings that indicate where to shorten or lengthen the pattern, if necessary. More extensive adjustments may require adding inserts or making tucks in the pattern pieces.

Laying out the pattern. A layout guide shows how the pattern pieces should be arranged on the fabric for cutting. It also tells whether the pieces must be cut in a single or double thickness of the fabric. Most pieces will be aligned with the *lengthwise grain*—that is, the vertical threads of the fabric. These threads run parallel to the *selvages*, the finished edges of the fabric. *Bias* pieces are laid out and cut diagonally across the grain. Cutting with or across the grain affects the way a garment will hang when worn.

After pinning the pattern pieces to the material, the pieces are cut out along the cutting line of the pattern. All buttonhole locations, centre markings, and *darts* (short, tapered folds that give a garment its shape) should be outlined on the fabric. Chalk, pins, *marking pens*, or a *tracing wheel* and paper may be used for marking. Marking pens have special ink which fades after a few days. A tracing wheel is a small wheel with a handle attached. It is used with tracing paper to transfer markings from a pattern to the cloth.

Sewing the item

Cotton, wool, and other fabrics made from natural fibres are sewn with *mercerized* cotton thread. Mercerizing is a chemical treatment that increases the lustre and strength of thread. Silk thread is used to sew silk fabrics. Synthetic fabrics require a synthetic thread or a combination synthetic-and-cotton thread. This type of thread is also used for wool and stretch fabrics.

Most patterns give step-by-step instructions for sewing a garment. The sewing process may include making darts, seams, fastenings, facings, linings, and hems.

Darts are placed at the shoulders, elbows, bustline, and waistline of a garment. To make a dart, the fabric is folded with right sides together along the centre of the marked dart, and pinned. The dart is then tacked and stitched from the wide end toward the point.

Seams are formed by sewing the right sides of two fabric pieces together. Seams are usually sewn 1.5 centimetres from the edge with a straight machine stitch. When sewing curved seams, one section of fabric may be slightly longer than the other, and *easing* is neces-

sary. When easing, the sewer keeps the longer section uppermost, matches the markings, and avoids gathers while stitching.

The edges of seams should be *finished* (smoothed) to prevent fraying. The sewer may cut the edges with *pink-ing shears*, which trims the edges in small scallops. However, it is better to overcast the edges by hand or machine.

Fastenings include buttons, zips, press studs, and hooks and eyes.

Buttons are attached to a garment with small stitches. Buttonholes are made by hand with a buttonhole stitch or by machine with a zig zag stitch. *Bound buttonholes* are made with small folded strips of fabric. These strips are stitched to form "lips" around the opening.

Zips are usually applied by the *slot*, or *centred*, method. The opening is tacked closed and the seam pressed open. The zip is tacked face down over the seam on the inside. The sewer machine stitches around the zip and then removes the tacking stitches. *Invisible zips*, which look like seams from the outside, require a special machine attachment to insert.

Press studs or hooks and eyes are used for neck and waistline openings to control the fit of a garment. They are hand sewn to the inside of the garment.

Facings finish off a garment's raw opening edges. *Self-facings* are extensions of the garment that form a fold at the opening edges. *Shaped facings* are separate pieces of the fabric that are sewn along the edge and turned to the inside of the garment. *Interfacings* are pieces of lightweight fabric placed between the facing and the outer garment to add firmness to a specific area.

Linings cover the inner surface of a garment. Lining pieces are stitched together and then hand sewn to the inside of the garment.

Hems finish off the bottom edges of garments and sleeves. Hem depths vary with the garment style and fabric weight. The bottom edge of the garment or sleeve is turned to the inside and sewn in place by hand or machine. Depending on the fabric, the sewer may use the hemming stitch, the blindstitch, the slipstitch, or the catchstitch to finish the bottom edges.

Related articles in World Book include:

Appliqué	Embroidery	Sewing machine
Button	Knitting	Textile
Clothing (Ready-to-wear clothes)	Needle	Thread
Crocheting	Scissors	Zip

Sewing machine is a machine that uses a needle to bind materials together with thread. It has lightened household work and helped families to have better and less expensive clothing than they might otherwise have had. In factories, it has helped make possible the mass production of clothing.

Kinds of sewing machines. There are various kinds of machines available for the domestic and commercial market. The three main types of sewing machines for the home are: (1) straight-stitch, (2) swing-needle, and (3) electronic. All three kinds are available in cabinet and portable models, and they may also have a *free-arm*, or *open-arm*, design for easier sewing around trouser legs, collars, cuffs, and shirt sleeves.

Straight-stitch sewing machines are designed for simple sewing that requires no decorative stitching. Various

attachments can be added to the machine to help make buttonholes, ruffles, and hems.

Swing-needle sewing machines, also called *zig-zag sewing machines*, are designed for special stitching as well as straight stitching. The needle swings from side to side to make zig-zag and other special stitches.

Electronic sewing machines are designed to make all kinds of stitches. The touch of a button or the insertion of a cartridge changes the motion of the needle so that it embroiders, makes buttonholes, monograms, or combines stitches. Electronic sewing machines have become increasingly computerized. For example, some machines can measure a button and then make as many buttonholes of the same size as are needed.

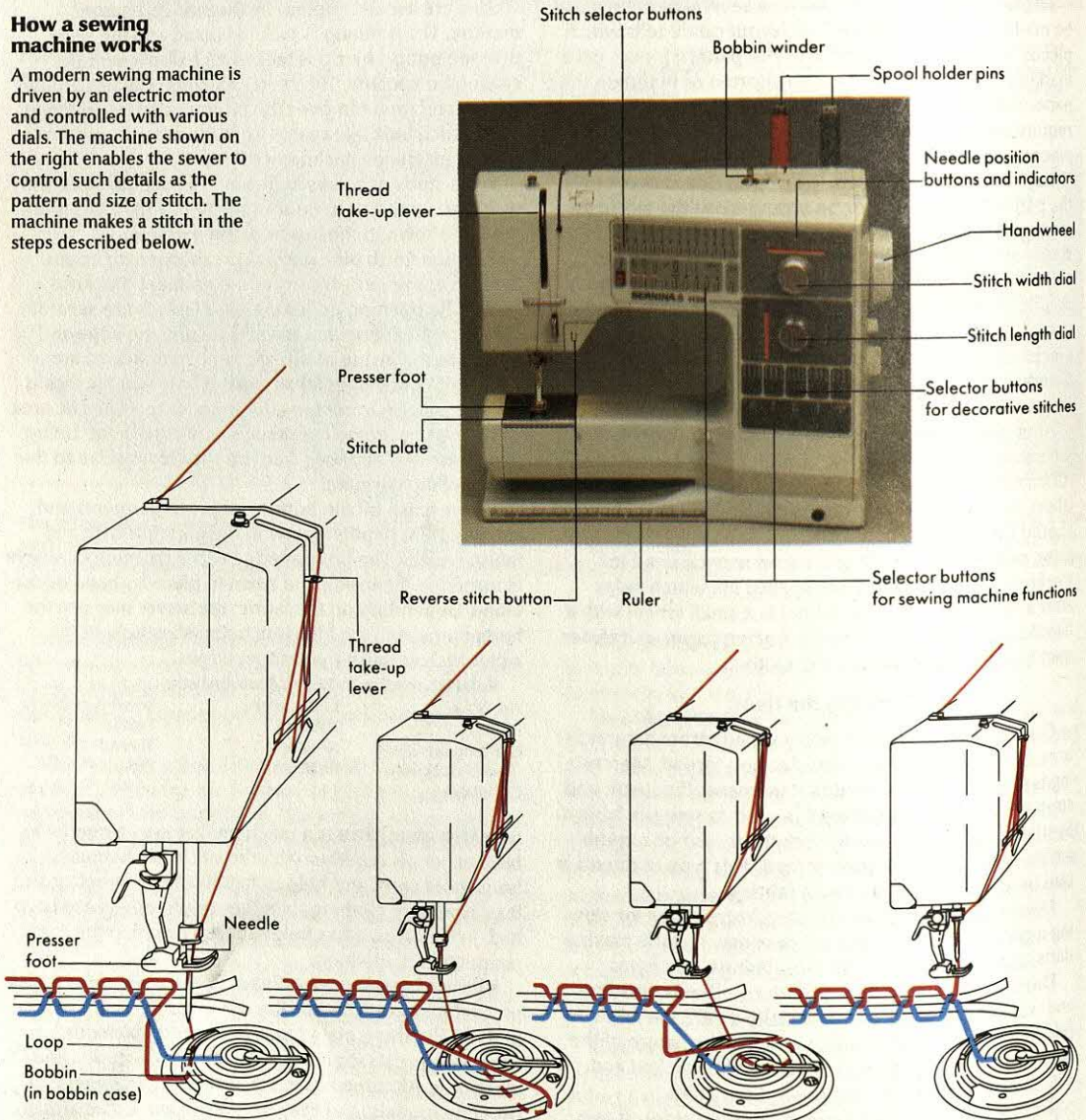
How a sewing machine works

A modern sewing machine is driven by an electric motor and controlled with various dials. The machine shown on the right enables the sewer to control such details as the pattern and size of stitch. The machine makes a stitch in the steps described below.

Although sewing machines are manufactured in many countries, those made in Japan and Europe are the best quality.

History. Thomas Saint, an Englishman, patented the first sewing machine in 1790. It was wooden, and made a single-thread chain stitch to stitch leather. The machine fed the thread automatically to a needle which had a notch instead of an eye. An awl made holes for the needle to pass through the leather. This machine was not practical.

In 1830, Barthélemy Thimonnier (1793-1859) of France patented a machine for making soldiers' uniforms. His machine used a hooked needle that made a stitch by passing backward and forward through the cloth. The



1. A stitch is made with thread from the needle and the bobbin. First, the needle and its thread enter the cloth.

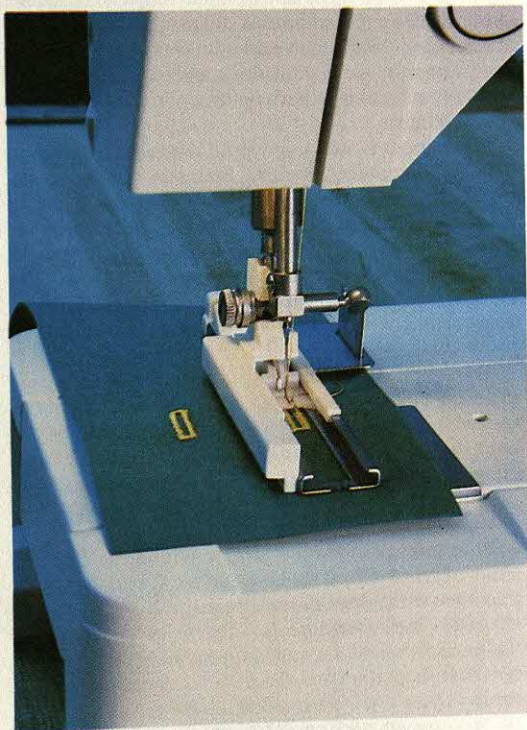
2. As the needle rises, its thread forms a loop. The loop goes around the bobbin and circles the bobbin thread.

3. The loop slips off the bobbin as the bobbin rotates. The needle rises and the stitch tightens around the cloth.

4. When the needle point is above the cloth, the fabric feed pulls more cloth forward and another stitch begins.



Sewing machine attachments enable a sewer to add decorative and functional features to clothing. A monogrammer attachment, *left*, makes letters of various sizes and designs. A ruffler attachment, *below left*, gathers material. A special buttonhole presser foot, *below right*, guides the sewer in making basic buttonholes. Other attachments apply zips, do embroidery, and simplify quilting. Many tasks, such as darning socks and sewing on buttons, can be done without special attachments.



French government had as many as 80 of these machines in use at one time. Thimonnier was almost killed when angry workers wrecked his machines because they put many people out of work. An American, Walter Hunt, invented a type of sewing machine in the 1830's, but never patented it.

Elias Howe, an American, is usually considered the inventor of the sewing machine as we know it today. His model, patented in 1846, was the first practical machine sold to users. Howe's machine had a needle with an eye near the point. A shuttle carried a thread below the cloth on a small bobbin. The needle, carrying an upper thread, was fastened to an arm that vibrated on a pivot. Movement of the arm forced the needle through the cloth. The shuttle carried the under thread through the loop of the upper thread, thus making a lock stitch. Nearly all sewing machines used in the home today are of this double-thread, lock-stitch type. But the lock stitch is less likely to ravel than the chain stitch, which is somewhat like the stitch used in crocheting.

Of the inventors who came after Howe, Americans A. B. Wilson and Isaac Singer deserve special mention. Wilson introduced the four-motion automatic feed used on nearly all present-day machines. Wilson's automatic feed sewing machine was patented in 1854. In 1851, Singer had patented the foot-operated treadle and the

presser foot with a yielding spring, which holds the fabric down on the feed plate.

Today, there are special machines for sewing boots and shoes, books, umbrellas, and brooms. There is even a machine for sewing carpets together. It travels along the carpet, because the carpet is too heavy to be moved easily. The Singer Manufacturing Company (now The Singer Company) first put an electric motor on a sewing machine in 1889. Today most domestic sewing machines are electric, but hand and foot treadle machines can still be found. People often use treadle machines in developing countries where electricity may not be available.

See also **Howe, Elias; Singer, Isaac Merrit; Sewing.** **Sex** is what makes males and females different from each other. It also attracts them to each other and involves deep feelings and desires. Through sex, a man and a woman may become interested in each other, fall in love, get married, and have children. Higher animals and plants produce their own kind, generation after generation, by means of sexual reproduction. For human beings, however, sex involves much more than reproduction. It has natural and important biological, psychological, and sociological effects on their lives.

Everyone is aware of sex because it influences everyone's personality and way of living. At the moment of birth, a baby is recognized as a boy or a girl. This recog-

nition has an effect on the way the baby is raised. Throughout their lives, males and females are expected to behave in certain different ways.

Because sex usually involves much deeper personal feelings and desires than other areas of life, it is not discussed so openly as are other areas. As a result, many people are confused and bothered by their sexual feelings. Some view sex as something to laugh at, or to joke about. But throughout history, philosophers, scholars, and religious leaders have thought seriously about sex and its importance to individuals and to society. Most religions and cultures have developed moral standards concerning sex.

Because sex is such a powerful force, it is used in many ways to attract attention. Both males and females use various styles of clothing and grooming to make themselves attractive to one another. People know that "sex sells." A film, television show, book, or article or story that deals with sexual interests is likely to be popular. Many advertisements on TV and in newspapers and magazines use sexual appeals to attract attention to their products.

This article discusses sex as it is related to the lives of children, teenagers, and adults. For a description of the methods by which human beings and various kinds of animals and plants reproduce, see the *World Book* article on **Reproduction**.

Males and females

Boys and girls. Throughout childhood, the most obvious physical difference between the sexes is in the appearance of the *genitals* (sex organs). A boy has a finger-shaped organ called a *penis* between his legs. Behind the penis is a small sac called the *scrotum*, which holds two oval-shaped organs, the *testicles*. A girl's external reproductive organs are called the *vulva*. The outer parts of the vulva are small folds of flesh that cover the opening to the *vagina*, a narrow passage that leads to other female sex organs—including the *uterus* and the *ovaries*—inside the body. In later years, after the sex organs have developed completely, a boy can become a father, and a girl can become a mother.

Puberty is the period of rapid growth that marks the end of childhood and the beginning of physical and sexual *maturity* (full development). During puberty, the bodies of boys and girls change noticeably, as do many of their feelings.

At the beginning of puberty, most girls are taller and grow faster than boys of the same age. After boys begin their period of rapid growth, they soon catch up. Many young people worry because some of their friends are growing and maturing more quickly than they are. But differences in the age at which puberty begins and in the rate of development during puberty are entirely normal. Some boys and girls mature several years earlier or later than others of their age.

Whether a girl matures slowly or rapidly, she and other girls go through the same changes as they enter womanhood. She grows taller, and her breasts become larger and round out. Her hips become wider, and hair grows under her arms and around her vulva. The widened hips will make it possible for her to give birth. The enlarged breasts will allow her to feed her babies milk from her own body.

One of the changes that takes place during a girl's growth to womanhood is the beginning of *menstruation*. Menstruation, a monthly discharge of blood and tissue from the vagina, is a normal part of a woman's life. Most girls start to menstruate when they are about 12 years old, but many begin at an earlier or later age than this. See **Menstruation**.

As a boy goes through puberty, he becomes taller and heavier. His shoulders broaden, he gets stronger, and his voice becomes deeper. Hair grows on his face, under his arms, around his genitals, and on other parts of his body. Most boys consider the appearance of hair on the face one of the most important steps to manhood.

When a boy nears sexual maturity, his sex organs become larger and he may experience *nocturnal emissions*, also called "wet dreams." Nocturnal emissions occur when a whitish fluid called *semen* is released through the penis while a boy or a man is sleeping. They are a natural way of releasing semen.

For both boys and girls, the development of the sex organs is accompanied by noticeable sexual feelings and tensions. Sometimes these tensions are relieved by *masturbating* (rubbing or handling the genitals). In the past, many people believed that masturbation caused various mental and physical problems, including insanity and pimples. These ideas have been proved false. But many people believe that masturbation can be morally wrong because it is a misuse of sexual powers. Masturbation can become an emotional problem if it causes people to feel anxious, guilty, or ashamed.

Sex roles. Most men and women differ from each other not only in anatomy, but in behaviour and interests as well. Some of these differences are biologically determined. For example, research indicates that males are more aggressive than females largely because of the male sex hormone *testosterone*. But many nonanatomical differences appear to be based on sex roles that are learned by every individual. People are born male or female, but they learn to be masculine or feminine.

Every society has certain common beliefs regarding the ways each sex should behave. In Western society, for example, women have traditionally been considered more tender and sympathetic than men. Men have been regarded as more competitive and less emotional than women. Most people traditionally associate women with such careers as homemaking and nursing, and men with such vocations as business and politics.

Individuals receive informal but powerful impressions of the roles they are expected to play as boys or girls and as men or women. This learning of sex roles begins in infancy. In many cases, members of the family and friends play more roughly with baby boys than with baby girls. Little girls are cuddled and handled more gently than are little boys in many homes. As children grow, their families provide informal lessons in masculinity and femininity. They encourage a child to behave in ways they feel appropriate for his or her sex, and they discourage any conduct considered inappropriate. For example, parents may reward a daughter's interest in sewing and housekeeping with praise and encouragement. But they might actively discourage a son who shows similar interests.

Both boys and girls learn sex roles by identifying with

the parent—or some other person important to them—of the same sex. Young girls copy their mother's activities and behaviour, and young boys imitate their father's manner and interests. Many experts believe that children have a firm sexual identity by the age of 3. They know much about the roles considered appropriate for their own and opposite sex. After entering school, other children provide further impressions of sex roles that are acceptable or unacceptable. During adolescence and adulthood, people learn what is expected of their own and the other sex at work and play, with the same sex and in mixed groups.

Since the 1960's, sex roles in many Western nations have become increasingly flexible. For example, many people no longer regard fear or tenderness as unmanly emotions. Similarly, a woman can be assertive or competitive and still be considered feminine. Men and women can also hold jobs that were once considered inappropriate for their sex.

Sexual relationships

As boys and girls become aware of their developing sexuality, they may be disturbed about the changes they are experiencing. At the beginning of puberty, young people may associate mainly with members of their own sex, who are going through the same changes. As they become more mature and surer of themselves, they become increasingly interested in members of the opposite sex.

During adolescence, boys and girls gradually learn how to get along in more grown-up ways with people of both sexes and of all ages. They adjust to the bodily changes they experienced during puberty. They learn to become more independent and to make their own decisions. And they discover new ways of developing relationships with the other sex.

Boy-girl relationships. In many countries, boys and girls grow up together and become accustomed to one another long before they reach adolescence. Throughout childhood, they play together, go to school together, and take part in many of the same activities together. During the teen years, boy-girl relationships become much more important and more complicated. As teenagers mature emotionally, sexually, and socially, they seek closer, more personal relationships with members of the opposite sex.

In the early teens, when boys and girls first begin to take a special interest in each other, they usually get together in groups. Meeting places may include schools and churches. Young people enjoy games, swimming, club meetings, various projects, and other group activities. These group activities give boys and girls an opportunity to discover themselves in different situations and with a variety of persons of both sexes. Such social experiences help individuals become more sure of themselves, and prepare them for the next step in boy-girl relationships.

The age at which boys and girls start to go out together, like the time it takes them to mature, varies greatly between individuals. Many teenagers will start the relationship by going out with another couple or a group of couples.

Going together as a couple involves many responsibilities and requires maturity on the part of both the boy

and girl. Generally, the boy asks the girl to go out with him. He is usually expected to set the time and place for the occasion, assume responsibility for the girl. Both the boy and the girl are expected to dress appropriately and to be courteous and pleasant. They also are expected to conduct themselves in ways that would be approved by their families, their friends, and themselves.

As adolescents mature and become more at ease with one another, their emotional and physical attraction to members of the other sex increases. Both boys and girls want their appearance and actions to make them attractive to one another. They enjoy doing ordinary things together that bring them close to one another. A boy and girl get a sense of being desirable when they look into each other's eyes, laugh together, hold hands, and sit close to each other. Kissing has special importance because both boys and girls want more intimate contact with one another. There comes a time when the boy, or the girl, or both, want closer physical contact than holding hands and kissing.

It is important that teenagers understand and manage their sexual desires. When they do, they are likely to have enjoyable and rewarding relationships with members of the opposite sex. If they do not, they could become more physically and emotionally involved than they intend to or are ready to.

Sexual desires can lead to *sexual intercourse*, the closest and most intimate form of physical contact. Sexual intercourse can start the process of reproduction. It could lead to an unmarried girl becoming pregnant. Most teenagers, both boys and girls, are physically able to have children. But few teenagers are ready to take on the responsibilities of marriage or parenthood. Most unmarried young people who have babies have been carried away by their sexual feelings and by emotional desires they have not controlled. Sexual intercourse also involves important moral standards and deep personal feelings. It can cause serious moral, social, and psychological problems for young people. The responsibility for controlling sexual desires belongs to both the boy and the girl.

Love. After two people get to know each other well, they may feel they are in love. They begin to understand one another better than ever before. They enjoy being together as much as possible in many different situations and moods. They may come to care deeply for one another when each wants to cherish and protect the other. They enjoy doing things for one another, and find pleasure in sharing things and in discussing their feelings with each other.

There are many forms of love feelings. One of the questions a person must face is whether he or she is really in love at a particular time. For example, some people mistake physical desire for love. But love based mainly on sexual attraction does not last long. A normal young person may fall in and out of love several times before establishing a lasting relationship.

Marriage and the family

When a man and woman love one another, they usually want to get married and spend the rest of their lives together. But a successful marriage involves more than just being in love. Being married and raising children requires a couple to be mature enough to accept and

enjoy new responsibilities. They must be ready to make many adjustments in their ways of living, and be financially able to support themselves.

A husband and wife express their love for each other in many ways. One of the most intimate ways is through sexual intercourse. During intercourse, a man and woman lie close together and the man's penis is placed in the woman's vagina. This is usually psychologically and physically very pleasurable for both persons.

During intercourse, semen is released from the penis into the vagina. The semen contains millions of tiny male sex cells called *sperm*. Sometimes, but not always, a sperm fertilizes (unites with) a female sex cell called an *egg*. If this happens, a baby starts to develop inside the female and is born about nine months later. Many couples want to prevent some pregnancies in order to regulate the birth of their children. They plan their family by using some method of *birth control* (see **Birth control**). Some couples choose to remain childless.

With the birth of children, a couple's life changes greatly. A baby is helpless and depends on its parents for the love and care it needs. The child is best assured of healthy, happy development if the parents love each other and want to have a baby. So it is especially important that love, sex, and family living go together.

Sexual intercourse between people who are not married to each other is considered morally wrong by many religious groups and by many people. Sexual relationships outside marriage can result in feelings of guilt and other psychological problems for the people involved. They can also result in the birth of an unwanted child.

Changing attitudes about sex

Until the mid-1900's, most people in Western countries did not openly talk about sex. The subject was masked in giggles, blushes, and "dirty stories." Today, however, sex is much more frequently discussed as a normal part of human life. Newspapers and television report on research into human sexuality, and books and magazine articles discuss the pleasures and problems of sexual situations.

The increased openness about sex encourages many parents to talk about it freely with their children. Large numbers of schools and churches offer courses in sex education for children and other young people of various ages. Marriage counselling and family life education help parents feel at ease with their own sexual interests and those of their children.

People have become freer to express their real feelings than they once were. Both men and women feel less restricted by traditional concepts of masculinity and femininity. Members of both sexes and people of all ages have more freedom to enjoy one another.

Sex, when properly understood and channelled, can bring great satisfaction to human beings. But most people agree that this powerful natural force must be controlled to assure fulfilment not only of the individual, but of society itself.

Related articles in *World Book* include:

Adolescent	Sex education
Homosexuality	Sexually transmitted disease
Marriage	Transsexualism
Prostitution	
Reproduction	

Sex education is the study of the characteristics of being a male or a female. Such characteristics make up a person's *sexuality*. Sexuality is an important aspect of the lives of human beings, and almost all people—including children—want to know about it.

Traditionally, children have received information about sexuality from their parents. They also may learn about sexuality through their church, their friends, their doctor, or other sources. But many young people fail to receive adequate sex education from the traditional sources. In addition, youngsters often get incorrect information about sexuality from their friends.

Many people believe that sex education in schools assures children of correct and complete information about sexuality. But others insist that children should learn about sexuality only from their parents.

The dispute over sex education. Surveys show that many parents, psychologists, and teachers favour some kind of sex education programme in schools. Opponents of such programmes argue that children should learn about sexuality only from their parents. They feel that children need moral guidance when being taught about sexuality, and that only parents can provide this guidance. Some opponents of sex education charge that it causes young people to think about sexuality too much. Other opponents believe that few teachers have the proper training to teach children about sexuality.

People who favour sex education in schools declare that parents have not done a good job of teaching about sexuality. They fear that children often receive false information from their friends and from magazines, the cinema, and television. Therefore, they argue, school is the best place for children to receive correct and complete information about sexuality. Most supporters agree that sex education teachers need special training.

See also **Sex**; **Calderone, Mary S.**

Sex ratio is the proportion of males to females in a population. Studies of birth records for human beings and other animals indicate that many species have more individuals of one sex than of the other. Among human beings, for example, 103 to 107 boys are born for every 100 girls. In the adult population, however, women outnumber men because women, on the average, live longer. Horses give birth to about 98 males for every 100 females. Chickens have about 95 males to every 100 females.

Sextant is an optical instrument that measures the angular distance between any two points, such as the sun and the horizon. It is used for navigation and surveying. The instrument is named after its shape, which is roughly a sixth part of a circle. A sextant's frame supports a graduated arc, a movable *index arm* that represents the radius of the circle, two mirrors, and a small telescope. One of the mirrors is fixed and is called the *horizon glass*. The second mirror is screwed to the index arm and is called the *index glass*. The telescope sharpens the line of the horizon.

The sextant is held so that the arc is vertical and the horizon shows in the horizon glass. The operator looks through the telescope at the horizon glass. Then the index arm is moved until the image of the sun or a certain star, reflected in the index glass, touches the horizon line. The altitude of the sun or star may be read from the graduated arc. The operator then compares



A navigator uses a sextant to measure the angle between a star and the horizon. Navigators must know this angle in order to find their position at sea by celestial navigation.

this altitude at various degrees of latitude and thus finds the latitude of the ship.

The sextant works according to the optical rule: If an object is seen by repeated reflection from two mirrors that are perpendicular to the same plane, the angular distance between the object and its image is double the angle between the surfaces of the mirrors. The sextant's index measures the angle between the mirrors. This reading is doubled to give the angular distance of an object, such as the sun, above the horizon.

The mirror sextant was developed in the mid-1700's. Its design was based upon the work of John Hadley in England and Thomas Godfrey in America. The sextant was the primary navigation tool used on ships and aircraft until the mid-1900's. After World War II (1939-1945), such electronic aids as loran, omega, and radar began to replace the sextant.

See also Navigation.

Sexton beetle. See Burying beetle.

Sexually transmitted disease, also called STD, is any disease spread primarily through intimate sexual activity. Many bacteria, viruses, and other kinds of germs cause STD's. STD's were once commonly called *venereal diseases*. They are a major health problem throughout the world.

How STD's are transmitted. STD's are transmitted almost entirely through intimate sexual contact with an infected person. STD's are rarely, if ever, transmitted through contaminated objects, such as eating utensils, towels, and toilet seats; or through casual contact, such as coughing, sneezing, or swimming in the same swimming pool. AIDS and a few other STD's may be transmitted through direct contact with infected blood (see AIDS).

All of the common STD's can be transmitted from an infected pregnant woman to her baby. Transmission may occur as the fetus develops within the uterus or during childbirth.

Factors in the spread of STD's. In general, people who begin sexual activity at an early age, have many sex

partners, or have sex with high-risk individuals—such as prostitutes—are at high risk of infection. The frequency and duration of intercourse with an infected partner also influence a person's risk of infection with an STD.

In the United States, researchers have documented five social changes that have played a part in the spread of STD's since the 1960's. These changes are (1) a dramatic increase in premarital sexual intercourse, (2) a decrease in the average age at which people first have intercourse, (3) increased acceptance of having more than one sex partner, (4) a rise in the divorce rate, and (5) a fall in the remarriage rate. All these changes have contributed to an increase in the number of sexually active people at risk of being infected with an STD.

Within any society, there are STD-infected individuals whose sexual behaviour makes them highly likely to transmit the STD to others. These individuals, known as *high frequency transmitters*, tend to be sexually active without regard to the risk of transmitting the STD. They also tend to delay seeking treatment for their illness. Social circumstances such as poverty and lack of education may influence the number of such individuals in a community.

Biological factors also can affect a person's risk of STD infection. Individuals with genital ulcers may be more vulnerable than others to infection by the AIDS virus. In addition, some STD-causing organisms become resistant to the drugs used for treatment. For example, some forms of the bacterium that causes gonorrhoea have become resistant to penicillin and other antibiotics commonly used to treat this infection (see *Gonorrhoea*).

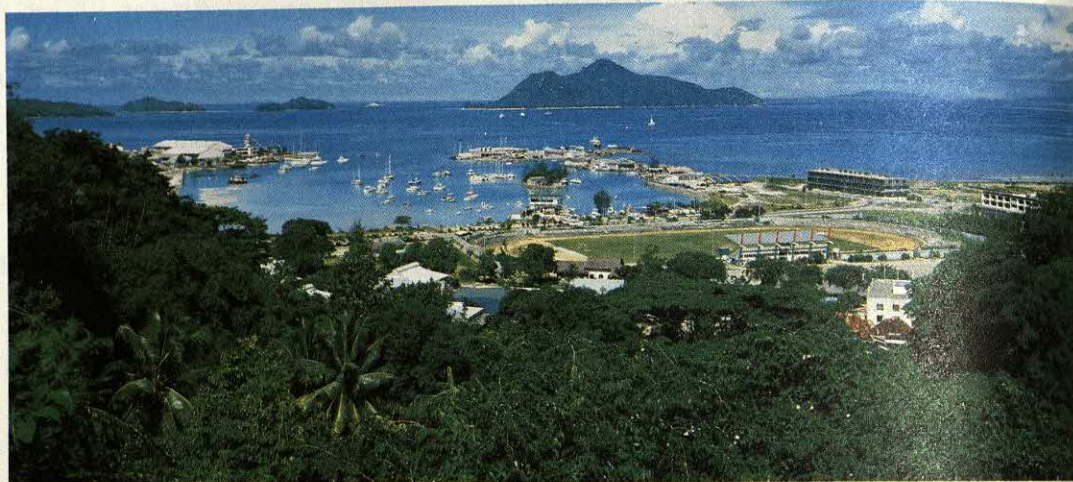
Diagnosis and treatment. Doctors use a number of methods to diagnose STD's. The first step usually involves identifying the patient's symptoms as those of an STD. Doctors may then do a variety of laboratory tests to confirm the presence of the infecting organisms. For example, they may perform a blood test to identify substances called *antibodies*, which the body produces in response to disease-causing organisms.

Doctors prescribe antibiotics to treat a variety of STD's. Such STD's, which include chlamydia, gonorrhoea, and syphilis, can be cured easily if the drugs are prescribed early in the course of the illness. However, failure to receive prompt treatment can lead to serious, even life-threatening, complications. For example, untreated syphilis can lead to heart or brain damage.

Viral STD's, including herpes and AIDS, are incurable. Patients may carry these infections for many years without developing symptoms. In addition, in herpes and certain other viral STD's, patients may experience symptoms that go away, only to recur months or years later. Doctors can prescribe drugs that reduce the severity of symptoms when they appear, and may prevent or delay the development or recurrence of symptoms.

Prevention and control. The most effective strategies to stay free of an STD are to abstain from intimate sexual contact altogether, or to limit such contact to one uninfected partner who, in turn, has no other sexual partners. People can significantly reduce the risk of infection by using condoms or other protective measures during sex and by avoiding sex with prostitutes and other high-risk individuals.

Controlling the spread of chlamydia, syphilis, and other bacterial STD's requires early treatment of in-



Victoria, on the island of Mahé, is the capital and chief port of Seychelles. The harbour was re-built in 1975 to accommodate ocean-going vessels up to 210 metres long. About one-third of the Seychellois people live in Victoria, the nation's only town.

fectured individuals and their sexual partners. Many hospitals and community health centres have special clinics for the treatment of STD's. Individuals who believe they may have an STD should see a doctor immediately. They should also stop all sexual activity until told by a doctor that they are not at risk of infecting others.

See also **AIDS; Chlamydia; Gonorrhoea; Herpes, Genital; Pelvic inflammatory disease; Syphilis; Disease.** (table: Some communicable diseases).

Seychelles is an African country that consists of about 90 islands in the Indian Ocean. The islands are scattered over 1,035,995 square kilometres. They lie about 1,600 kilometres east of the African mainland.

Seychelles has a total land area of 455 square kilometres and a population of 74,000. The largest island, Mahé, covers 153 square kilometres. Approximately 85 per cent of the population lives on Mahé. Most of the rest of the people live on the next largest islands, Praslin and La Digue. Many of the smaller islands are uninhabited. Victoria, on Mahé, is the nation's capital, chief port, and only town. It has a population of about 24,000. Seychelles was ruled by the United Kingdom from 1814 until 1976, when it became independent.

The country's basic unit of money is the rupee. For a picture of the nation's flag, see **Flag** (Flags of Africa).

Government. Seychelles is a republic. The people elect a president, who heads the government and appoints a Cabinet. A 33-member Legislative Assembly makes the country's laws. Voters elect 22 members of the Legislative Assembly and 2 members are appointed by the president. The Seychelles Peoples United Party is the largest political party.

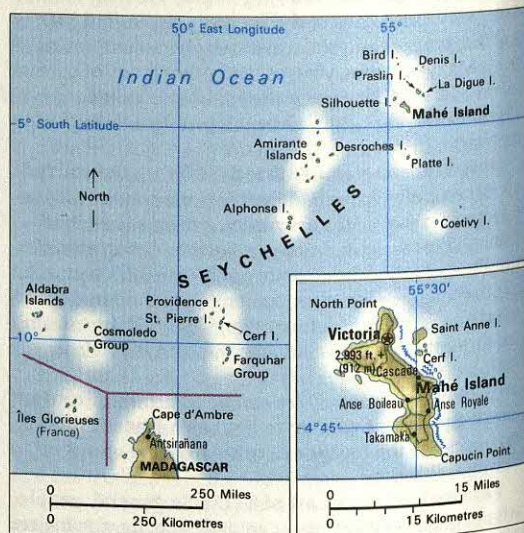
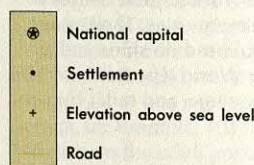
People. About 90 per cent of the people of Seychelles have mixed African and European ancestry. The others are Chinese, Europeans of British or French origin, and people from India.

About 50 per cent of the nation's people live in cities and towns. The rest live in rural areas. About 35 per cent of Seychellois workers are employed by the government. Another 25 per cent work in the construction or

the tourist industries, and about 15 per cent are farmers.

English and French are the country's official languages, but most of the people speak Creole, a dialect of French. Most Seychellois are Roman Catholics. Almost all Seychellois children attend school from the ages of 6 to 15. Some then join the National Youth Service, which provides academic instruction. Students also learn skills to help develop the nation, such as growing crops and fishing. The Polytechnic offers advanced voca-

Seychelles



tional training. Approximately 60 per cent of the people can read and write.

Many Seychellois men and women live together without being married, and about half the children are born to unmarried couples. In many cases, the woman provides clothing for herself and the children, and the man buys his own clothes and food for the family.

Land and climate. Seychelles consists of granite islands and coral islands. The granite islands have streams, mountains, and white, sandy beaches. The soil is fertile. But the land has many rocks, making farming difficult. The coral group is made up of *atolls* (ring-shaped coral islands) and low islands with reefs that rise a few feet above sea level. These islands cannot support much plant life, and many are uninhabited.

Cinnamon grows wild on much of Mahé, and coconut palms flourish on many of the islands. The *coco de mer*, a double coconut that weighs as much as 23 kilograms, grows only in Seychelles. The country has many unusual species of plants and birds, as well as giant tortoises.

Seychelles has a hot, moist climate. Annual temperatures average from 24 to 30 °C. The average annual rainfall ranges from 132 centimetres on some of the coral islands to 234 centimetres on Mahé.

Economy of Seychelles is based on tourism. The country's remote location and beautiful beaches attract many tourists. The tourist trade increased the need for hotels and restaurants, which led to the development of a construction industry during the 1970's.

A shortage of suitable farmland limits agricultural production in Seychelles. Cinnamon, coconuts, and *copra* (dried coconut meat) are the chief products. A growing fishing industry contributes to the economy.

An airport operates on Mahé, and a ferry travels daily among the three largest islands. The country has a TV station, a radio station, and two daily newspapers.

History. Portuguese sailors discovered Seychelles in the early 1500's. The islands were uninhabited at the time, and for the next 250 years they served chiefly as a hiding place for pirates. In 1742, an expedition from Île de France (now Mauritius) explored Mahé. France claimed the islands in 1756.

About 1770, a group of white planters and African slaves came from Île de France and settled on Mahé. For many years, Seychelles served as a supply station for French ships sailing to India and the East Indies. In the 1790's, war broke out between France and several European nations, including Great Britain. A treaty signed in 1814 gave Seychelles to Britain. Conditions declined under British rule. Britain did not establish schools there until 1944. In the early 1970's, many Seychellois began to demand an end to British rule. Seychelles became independent in June 1976. Since 1977, President France Albert René has been the country's most powerful leader. Until 1993, his Seychelles People's Progressive Front was the country's only legal political party. Opposition parties were allowed that year.

Seymour, Jane. See Henry (VIII) of England.

Seyss-Inquart, Arthur von (1892-1946), was the leading Austrian Nazi. As the adviser to the chancellor of Austria during the 1930's, Seyss-Inquart betrayed his country and helped Adolf Hitler seize Austria. When Austria became German territory in 1938, Seyss-Inquart became its governor. He held a similar post in the Neth-

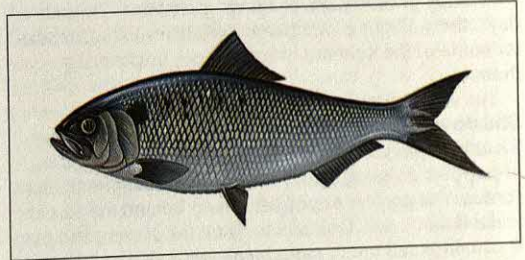
erlands during World War II (1939-1945). After the war, he was tried and hanged in Nuremberg for his repressive policies. He was born in Stannern, in Bohemia.

's Gravenhage. See Hague, The.

Shabuot. See Shavuot.

Shackleton, Sir Ernest Henry (1874-1922), an Irish explorer, led a British expedition from the Ross Sea that came within 180 kilometres of the south geographic pole in 1908 (see *Antarctica* [Early exploration]). In 1914, he led an expedition into the Weddell Sea, where ice crushed his ship, the *Endurance*. His party escaped in boats to Elephant Island. Shackleton and four companions then journeyed by boat to South Georgia Island and crossed the island's mountainous ridge to summon rescuers. As a result, his entire party was saved. Shackleton was born in County Kildare.

Shad is the name of several species of herring-like fish. Shad grow to about 60 centimetres long and weigh over 1 kilogram. The *American shad* is a popular food fish. It lives along the Atlantic coast of North America, from Newfoundland to Florida. It feeds on *plankton* (microscopic marine organisms), especially crustaceans called



Shad are fish with silvery sides. They are related to herrings. Most types live in the sea and migrate up rivers to spawn.

copepods. Shad are caught in nets as they migrate up rivers to spawn. Some shad are eaten smoked. Their *roe* (eggs) are eaten like caviar. The *twaité shad* lives in European seas. It is also called mayfish because it migrates up rivers at that time of year. Some twaité shad live in landlocked lakes and do not migrate.

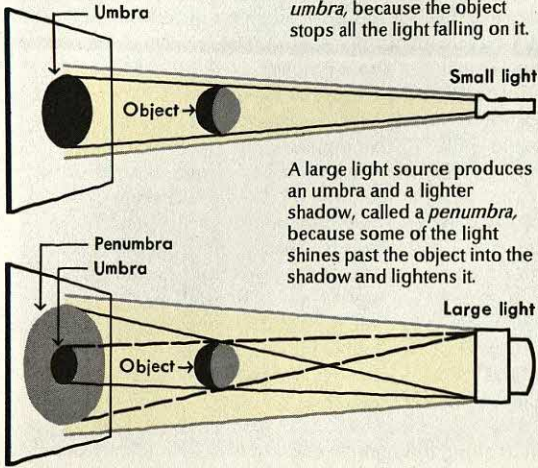
Scientific classification. Shad belong to the herring family, Clupeidae. The American shad is *Alosa sapidissima*, and the twaité shad is *A. fallax*.

Shadoof. See Agriculture (picture).

Shadow is the darkness that an object causes when it prevents light from shining on a surface. When you stand in sunlight, your body blocks some of the light that would have otherwise brightened the ground. Thus, that would have otherwise brightened the ground. Thus, your shadow is a dark area in the shape of your body. The earth casts a shadow in space, because it blocks some of the light from the sun. The moon darkens in a lunar eclipse when it moves into the earth's shadow.

A shadow falls from the side of an object opposite the light source. If the light source is smaller than the object, the shadow is evenly dark. A wide source of light creates a shadow with a dark centre called the *umbra*. The umbra is surrounded by a lighter region called the *penumbra*. The umbra is dark because the object blocks all the light directed toward that part of the surface. The penumbra appears when some of the light gets past the object and reaches the surface.

Types of shadows



A small light source produces a dark shadow, called an *umbra*, because the object stops all the light falling on it.

A large light source produces an umbra and a lighter shadow, called a *penumbra*, because some of the light shines past the object into the shadow and lightens it.

In bright sunlight, objects have dark, crisp shadows. On cloudy or hazy days, shadows are fainter. On such days, the sunlight is dimmer and particles in the air scatter some of the light into the shadows, brightening them.

See also Eclipse; Penumbra; Sundial.

Shadow Cabinet. See Parliament.

Shadow play is a kind of drama in which the figures of puppets or living actors are thrown in silhouette on a screen. The players or puppets stand behind the screen and a light throws their shadows on the screen. The play is usually acted out in *pantomime* (without words).

See also Puppet.

Shadwell, Thomas. See Poet laureate.

Shaffer, Peter Levin (1926-), a British playwright and critic, won fame with his play *Five Finger Exercise* (1958), in which he explored the hostilities between the various generations of a middle-class family. His later plays include *The Private Ear and the Public Eye* (1962), *The Royal Hunt of the Sun* (1964), *Black Comedy* (1965), *The Battle of Shrivings* (1970), *Equus* (1973), and *Amadeus* (1979). Some of his work has been filmed, and he has also written for television. Shaffer was born in Liverpool, England. He was educated at St. Paul's School, London, and at Cambridge University. Shaffer's twin brother, Anthony Shaffer, is also a playwright. His best-known play, *Sleuth*, also became a film. He also wrote the screenplays for the films *Death on the Nile* and *Evil Under the Sun*.

Shaftesbury was the title of two statesmen who belonged to one of Britain's most famous families.

Anthony Ashley Cooper (1621-1683), Earl of Shaftesbury, a statesman, was born in Wimborne, Dorset, and educated at Oxford University. He entered Parliament in 1640 and supported Oliver Cromwell during the Civil War and the Commonwealth. After Cromwell's death, he helped plan the restoration of the monarchy. King Charles II pardoned him for his anti-Royalist actions and made him Baron Ashley, Earl of Shaftesbury, and lord chancellor.

Shaftesbury became a member of the Cabal, Charles's inner council, worked to establish the Whig Party, and



Tempera painting on canvas (1931); collection of the Whitney Museum of American Art, New York City.

Shahn's *The Passion of Sacco and Vanzetti* was one of a series of 23 pictures the artist painted to protest against the execution in 1927 of two anarchists convicted of murder.

supported the Test Acts against the Roman Catholics. His support of the Test Acts eventually cost him his office. In 1679, Shaftesbury became president of the Privy Council and secured the passage of the Habeas Corpus Act. But he became involved in a plot against the king and was arrested. He escaped to the Netherlands, where he died. See Cabal; Habeas corpus; Test Act.

Anthony Ashley Cooper (1801-1885), Earl of Shaftesbury, was a statesman and philanthropist. He served in Parliament from 1826 to 1851. He sought to improve the treatment of the insane and the living conditions of the poor. He was born in London. The famous Eros monument, erected in 1893 in Piccadilly Circus, London, was built as a memorial to the Earl.

Shagbark. See Hickory.

Shah was the title of the ruler of certain Middle Eastern countries, including Iran. See Iran (History); Mohammad Reza Pahlavi; Reza Shah Pahlavi; Shah Jahan.

Shah Jahan (1592-1666) was the fifth ruler of the Mughal empire in India. He became ruler in 1627. During his

reign, the Mughals reached their golden age, with vaults crammed with treasures and with architecture in magnificent style.

Shah Jahan is best remembered for the perfectly proportioned Taj Mahal, an immense tomb of white marble built for his wife in Agra, India (see **Taj Mahal**). He also built a palace of unbelievable splendour in Delhi. These and other buildings still stand as examples of Mughal glory. The dynasty began its decline because too much money was spent on luxuries and too much effort was wasted in war. Shah Jahan's reign was a troubled one, and one of his sons took his throne by force.

Shah Namah. See **Firdausi**.

Shahn, Ben (1898-1969), an American painter, tried through his art to communicate with people and influence their thinking and emotions. His realistic paintings and drawings deal directly and powerfully with such themes as labour movements, race relations, and atomic warfare.

Shahn was born in Lithuania and moved to the United States when he was 8. He first attracted attention in the 1930's with a series of paintings about the controversial Sacco-Vanzetti murder trial of 1921. Many of his paintings are murals. Shahn was a skilled draughtsman and printmaker. He created both art prints and advertising illustrations because he saw no difference between fine art and commercial art. Shahn also expressed a compassionate interest in his fellow human beings in his photography. A series of his lectures on art was published as *The Shape of Content* (1957).

Shaka (1787?-1828) was a Zulu warrior who became king of the Zulu in southern Africa. He was born in southeastern Africa, in the land of the Elangeni people (present-day Melmoth). As a youth, he served in the armies of Dingiswayo, king of the Mthethwa clan. In 1815, Shaka's father Senzangakona died and Shaka took over the leadership of his father's small Zulu clan. In 1818, Dingiswayo was murdered and Shaka took over the leadership of his kingdom.

Shaka continued Dingiswayo's revolution of Zulu methods of warfare. He perfected a close-in encircling

fighting strategy. His Zulu armies conquered much of present-day Natal and Zululand, and gained great wealth in cattle. Clans and tribes were forced to flee, to pay tribute, or to join the Zulu kingdom. He became friends with British traders near Durban. Shaka's reign came to an end in 1828, when he was assassinated by his half-brothers. One of them, Dingane, succeeded him to the kingship (see **Dingane**).

Shakers are members of a religious sect in the United States called the United Society of Believers in Christ's Second Appearing. Members are called Shakers because early in their history they shook with emotion during religious services. The Shakers were founded about 1772 in Manchester, England, by Ann Lee.

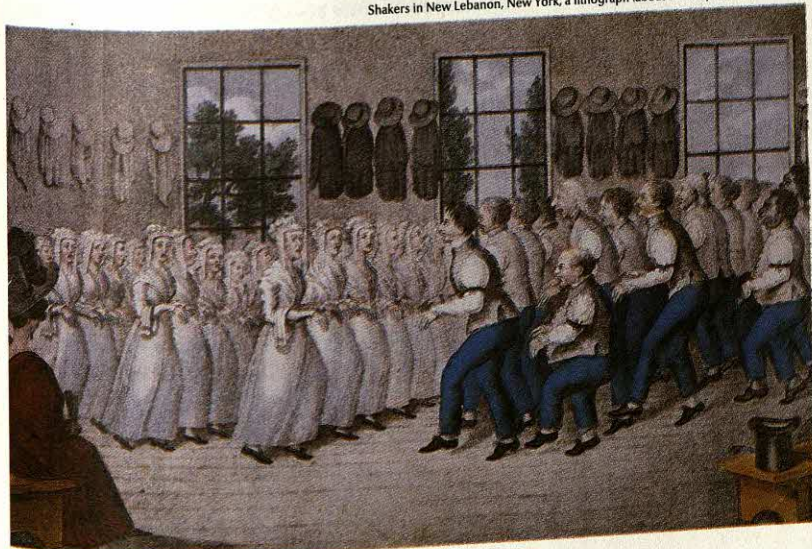
The basic principles of the sect include virgin purity, love, peace, and justice. Shakers express these principles through the practice of celibacy, universal brotherhood, nonviolence, and the sharing of all property and goods. They believe God is both male and female and that Ann Lee, called *Mother Ann*, was the reincarnation of Jesus Christ.

In 1774, Ann Lee and eight of her followers emigrated from England and settled in 1776 in Watervliet, New York. Lee's missionary activities attracted many converts. They began forming other Shaker communities based on Lee's teachings soon after her death in 1784. The largest, New Lebanon, New York, was founded in 1787 and served as the Shakers' mother community.

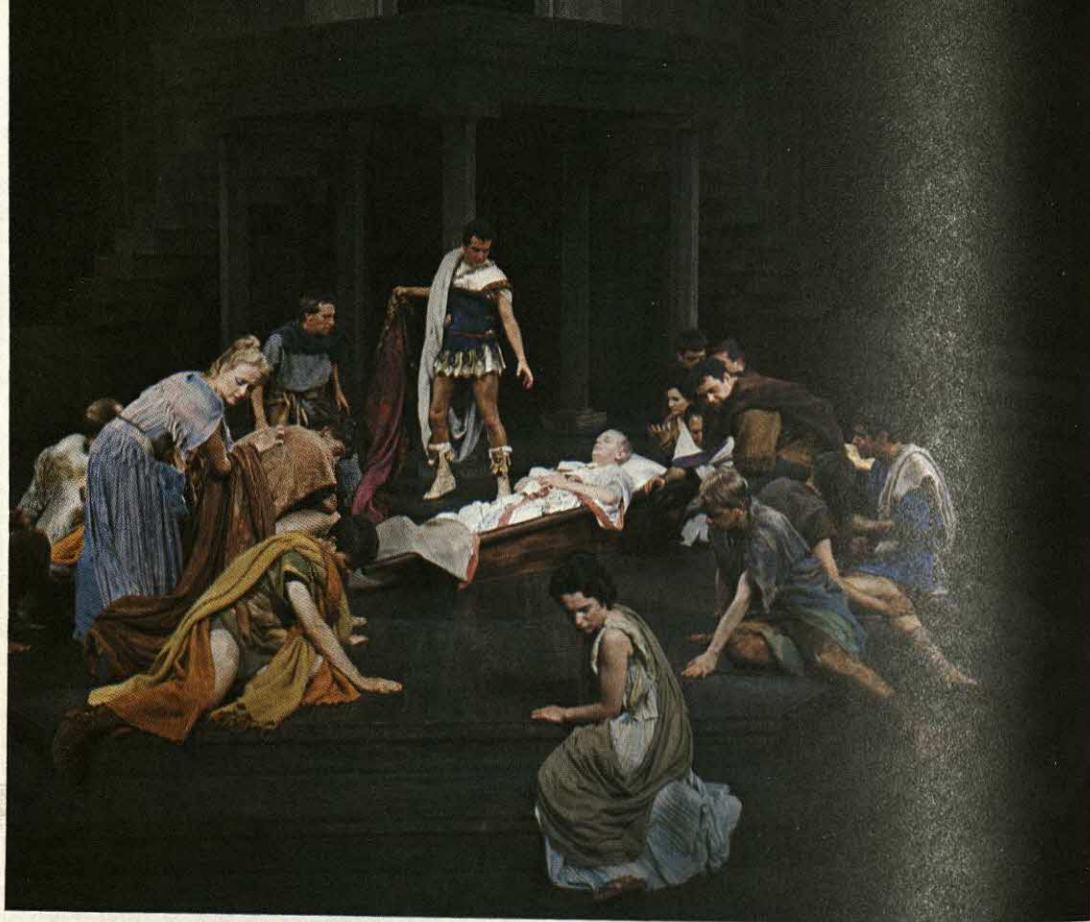
In about 1850, when the Shakers were at their height of popularity, about 6,000 members lived in communities from Maine to Kentucky. Their well-tended villages reflected their emphasis on efficiency and order. Such inventions as circular saws and clothes pegs reflected Shaker imagination and ingenuity.

Because Shakers do not believe in marriage or bearing children, they depend on conversions and adoptions to maintain membership. The number of Shakers began to decline after the end of the American Civil War in 1865. The few remaining Shakers live in two communities—Sabbathday Lake, Maine, and Canterbury, New Hampshire.

Shakers in New Lebanon, New York, a lithograph (about 1840) by Nathaniel Currier



Shakers at worship trembled and chanted wordless songs. A church leader said he saw the Hosts of Heaven worshipping in this manner, and he taught the movements to his people.



Highly dramatic scenes add to the power of Shakespeare's great tragedies. In this scene from *Julius Caesar*, the young Roman leader Mark Antony delivers an eloquent funeral address over the body of the assassinated Roman ruler Julius Caesar. Antony begins his address to a crowd of common people with the famous line "Friends, Romans, countrymen, lend me your ears."

William Shakespeare

Shakespeare, William (1564-1616), was an English playwright and poet. He is generally considered the greatest dramatist the world has ever known and the finest poet who has written in the English language. Shakespeare has also been the world's most popular author. No other writer's plays have been produced so many times or read so widely in so many countries.

During his lifetime, Shakespeare was well-known to people in England, but he was looked upon only as a writer of popular plays. He wrote his plays to suit the kind of audience that would be watching them. Yet his works can be enjoyed today, as they were by the people who saw them nearly 400 years ago.

Many reasons can be given for Shakespeare's broad appeal. But his fame basically rests on his understanding of human nature. Shakespeare understood people as few other artists have. He could see in a specific dramatic situation the qualities that relate to all human beings. He could thus create characters that have meaning beyond the time and place of his plays. Yet his characters are not symbolic figures. They are remarkably indi-

vidual human beings. They struggle just as people do in real life, sometimes successfully and sometimes with painful and tragic failure.

Shakespeare wrote at least 37 plays, which have traditionally been divided into comedies, histories, and tragedies. These plays contain vivid characters of all types and from many walks of life. Kings, pickpockets, drunkards, generals, hired killers, shepherds, and philosophers all mingle in Shakespeare's works.

In addition to his deep understanding of human nature, Shakespeare had knowledge in a wide variety of other subjects. These subjects include music, the law, the Bible, military science, the stage, art, politics, the sea, history, hunting, and sports. Yet as far as scholars know, Shakespeare had no professional experience in any field except the theatre.

Shakespeare was born to what today would be called middle-class parents. His birthplace was the small market town of Stratford-upon-Avon. Shortly after he married at the age of 18, Shakespeare apparently left Stratford to seek his fortune in the theatrical world of London. Within a few years, he had become one of the city's leading actors and playwrights. By 1612, when he seems to have partially retired to Stratford, Shakespeare

had become England's most popular playwright.

Shakespeare has had enormous influence on culture throughout the world. His works have helped shape the literature of all English-speaking countries and of such countries as Germany and Russia. Shakespeare also contributed greatly to the development of the English language. He freely experimented with grammar and vocabulary and so helped prevent literary English from becoming fixed and artificial.

Shakespeare's influence on language has not been limited to writers and scholars. Many words and phrases from Shakespeare's plays and poems have become part of our everyday speech. They are used by millions of people who are unaware that Shakespeare created them. For example, Shakespeare originated such familiar phrases as *fair play*, *a foregone conclusion*, *catch cold*, and *disgraceful conduct*. As far as scholars can tell, Shakespeare also invented such common words as *assassination*, *bump*, *eventful*, and *lonely*.

Many people can identify lines and passages as Shakespeare's even though they have never seen or read one of his plays. Examples include "To be, or not to be," "Friends, Romans, countrymen, lend me your ears," and "A horse! a horse! my kingdom for a horse!"

Shakespeare's genius as a poet enabled him to express an idea both briefly and colourfully. In his tragedy *Othello*, for example, he described jealousy as "the green-eyed monster which doth mock the meat it feeds on." In the tragedy *King Lear*, Shakespeare described a daughter's ingratitude toward her father as "sharper than a serpent's tooth."

Besides influencing language and literature, Shakespeare has affected other aspects of culture in the English-speaking world. His plays and poems have long been a required part of a liberal education. As a result, Shakespeare's ideas on such subjects as heroism, romantic love, and the nature of tragedy have helped shape the attitudes of millions of people. His brilliant portrayals of historical figures and events have also influenced our thinking. For example, many people visualize Julius Caesar, Mark Antony, and Cleopatra as Shakespeare portrayed them, not as they have been described in history books.

Even historians themselves have been influenced by Shakespeare's greatness. Shakespeare lived in England during the reign of Queen Elizabeth I, a period known as the *Elizabethan Age*. Historians consider the Elizabethan Age as a peak of English culture. But one can question whether the period would seem so important if Shakespeare had not lived and worked in it.

Shakespeare's widespread influence reflects his astonishing popularity. His plays have been a vital part of the theatre in the Western world since they were written more than 300 years ago. Through the years, most serious actors and actresses have considered the major roles of Shakespeare to be the supreme test of their art.

Shakespeare's plays have attracted large audiences in big, sophisticated cities and in small, rural towns. His works have been performed on the frontiers of Australia and New Zealand. They were part of the cultural life of the American Colonies and provided entertainment in the mining camps of the Old West. Today, there are

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A portrait of Shakespeare appears in the First Folio, the first edition of Shakespeare's collected plays. This portrait by the English artist Martin Droeshout is one of two images of the playwright considered authentic. The other is shown on page 303.

theatres in England, the United States, and Canada dedicated to staging some of Shakespeare's works yearly.

Shakespeare's plays appeal to readers as well as to theatregoers. His plays—and his poems—have been reprinted and translated countless times. Indeed, a publishing industry flourishes around Shakespeare, as critics and scholars examine every aspect of the man, his writings, and his influence. Each year, hundreds of books and articles appear on Shakespearean subjects. Thousands of scholars from all over the world gather in dozens of meetings annually to discuss topics related to Shakespeare. Special libraries and library collections focus upon Shakespeare. Numerous films have been made of his plays. Composers have written operas, musical comedies, and instrumental works based on his stories and characters.

The world has admired and respected many great writers. But only Shakespeare has generated such varied and continuing interest—and such constant affection.



Shakespeare's birthplace was probably one of these two adjoining houses in Stratford. According to tradition, the playwright was born in the house on the left, called the *Birthplace*.

During the Elizabethan Age, the English cared little about keeping biographical information unrelated to affairs of the church or state. In addition, playwriting was not a highly regarded occupation, and so Elizabethans saw little point in recording the lives of mere dramatists. However, a number of records exist that deal with Shakespeare's life. They include church registers and accounts of business dealings. Although these records are few and incomplete by modern standards, they provide much information. By relating these records to various aspects of Elizabethan history and society, scholars have filled in the gaps in the factual account of Shakespeare's life. As a result, they provide a reasonably clear and dependable biography of the playwright.

His life in Stratford

Shakespeare's parents. John Shakespeare, William's father, was a glove maker who owned a shop in the town of Stratford-upon-Avon. Stratford lies about 120 kilometres northwest of London in the county of Warwickshire. John Shakespeare was a respected man in the town and held several important positions in the local government.

William Shakespeare's mother was born Mary Arden. She was the daughter of a farmer but related to a family of considerable social standing in the county. John Shakespeare married Mary Arden about 1557. The Ardens were Roman Catholics. Mary may also have been a Catholic, but the Shakespeares publicly belonged to the Church of England, the state church.

Early years. William Shakespeare was born in Stratford in 1564, the third of eight children. The register of Holy Trinity, the parish church in Stratford, records his baptism on April 26. According to the custom at that time, infants were baptized about three days after their birth. Therefore, the generally accepted date for Shakespeare's birth is April 23.

The Shakespeares were a family of considerable local



A bedroom in the Birthplace is furnished in the style common among middle-class families of Shakespeare's day. Shakespeare may have been born in this room.

prominence. In 1565, John Shakespeare became an alderman. Three years later, he was elected *bailiff* (mayor), the highest civic honour that a Stratford resident could receive. Later, he held several other civic posts. But toward the end of his life, John Shakespeare had financial problems.

Beginning at about the age of 7, young William Shakespeare probably attended the Stratford grammar school with other boys of his social class. The school's highly qualified teachers were graduates of Oxford University. Students spent about nine hours a day in school. They attended classes all year round, except for three brief holiday periods. The teachers enforced strict discipline and physically punished students who broke the



The Stratford grammar school provided Shakespeare with all his formal education. He probably entered the school at about the age of 7. The school dates from 1417 and is still used.

rules. The students chiefly studied Latin, the language of ancient Rome. Knowledge of Latin was necessary for a career in medicine, law, or the church. In addition, Latin was considered a sign of an educated person. Young Shakespeare may have read such outstanding ancient Roman authors as Cicero, Ovid, Plautus, Seneca, Terence, and Virgil.

By modern standards, the Stratford grammar school must have been demanding, dull, and strict. And no evidence exists that Shakespeare had any teacher who might have stirred his imagination and brought routine studies alive.

In spite of the long hours he spent in school, Shakespeare's boyhood was probably not all boring study. As a market centre, Stratford was a lively town. In addition, holidays provided popular pageants and shows, including plays about the legendary outlaw Robin Hood and his merry men. By 1569, travelling companies of professional actors were performing in Stratford. Stratford also held two large fairs each year, which attracted numerous visitors from other counties. For young Shakespeare, Stratford could thus have been an exciting place to live in.

Stratford also offered Shakespeare other pleasures. The fields and woods surrounding the town provided opportunities to hunt and trap small game. The River Avon, which ran through the town, had fish to catch. Shakespeare's poems and plays show a love of nature and rural life. This display undoubtedly reflects his childhood experiences and his love of the Stratford countryside.

Marriage. In November 1582, Shakespeare received a licence to marry Anne Hathaway. She was probably the daughter of a farmer who lived in Shottery, a village about 1.5 kilometres from Stratford. At the time of their marriage, Shakespeare was 18 years old and Anne was 26. Their first child, Susanna, was baptized on May 26, 1583.

The lost years. Early in 1585, Anne Shakespeare gave birth to twins—a boy, Hamnet, and a girl, Judith. No significant factual information exists on Shakespeare's life for the period between Feb. 2, 1585, when the twins were baptized, and 1592, when evidence indicates Shakespeare was living in London. Scholars sometimes call this period *the lost years*.

Shakespeare's name appears with his parents' names in a Stratford lawsuit in 1588. But he may not have been living in Stratford at that time. Scholars believe that sometime during the lost years Shakespeare moved to London and served a period of apprenticeship in the city's busy theatrical life.

Early career in London

First recognition. There is some indication that Shakespeare had become well known in London theatrical life by 1592. That year, a pamphlet appeared with an apparent reference to Shakespeare. This reference suggested he had become both an actor and a playwright. A writer named Robert Greene had written a letter attacking theatre owners, actors, and writers who, he believed, had abused the talents of university-educated playwrights, such as himself. After his death, the letter

was published in a pamphlet called *Greene's Groatsworth of Wit Bought with a Million of Repentance*. Most scholars agree that in one passage Greene attacked Shakespeare as an actor who thought he could write plays as well as educated dramatists could. This passage follows, with the Elizabethan spelling and punctuation modernized:

... an upstart Crow, beautified with our feathers, that with his *Tiger's heart wrapped in a Player's hide*, supposes he is as well able to bombast out a blank verse as the best of you: and being an absolute *Johannes fac totum* [Johnny-do-everything], is in his own conceit the only Shakespeare in a country.

The line "Tiger's heart wrapped in a Player's hide" pokes fun at a line spoken by the Duke of York in Shakespeare's *Henry VI*, Part III. The line is "O tiger's heart wrapped in a woman's hide."

Following the publication of *Greene's Groatsworth of Wit*, Shakespeare must have complained about the attack to Henry Chettle, Greene's editor. Chettle then published an apology in which he appeared to praise Shakespeare as a polite and honest man as well as a fine writer. Part of Chettle's apology follows, with the spelling modernized:

... I am as sorry as if the original fault had been my fault because myself have seen his demeanour no less civil than he excellent in the quality [acting occupation] he professes: Besides, divers of worship [various people of good reputation] have reported his uprightness of dealing, which argues his honesty, and his facetious [polished] grace in writing, that approves his Art.

His work in theatre companies. Sometime after he arrived in London, Shakespeare probably joined one of the city's *repertory* theatre companies. These companies consisted of a permanent cast of actors who presented a variety of plays week after week. The companies were commercial organizations that depended on admission prices for their income. They staged most of the plays Londoners attended.

Scholars do not know which theatre company or companies Shakespeare joined before 1594. But he was a *sharer* (shareholder) of a company called the Lord Chamberlain's Men in 1594. The evidence consists of a record of payment to Shakespeare and his fellow actors for performances by the company at Queen Elizabeth's court. The Lord Chamberlain's Men was one of the most popular acting companies in London. Shakespeare was a leading member of the group for the rest of his career. By 1594, at least six of Shakespeare's plays had been produced.

His first poems. From mid-1592 to 1594, London authorities often closed the public theatres because of repeated outbreaks of plague. The need for new plays thus declined. At this time, Shakespeare began to write poems. The Elizabethans considered the writing of poetry much more important than the writing of plays. Shakespeare perhaps believed that by writing poems he might be able to win the praise that mere playwrighting never received.

In 1593, Shakespeare's long poem *Venus and Adonis* was printed by Richard Field, a Stratford neighbour who had become a London printer. Shakespeare dedicated

the poem to 19-year-old Henry Wriothesley, the Earl of Southampton. The poet may have believed that the dedication would win him the earl's favour and support. *Venus and Adonis* quickly became a success.

Field printed Shakespeare's next long poem, *The Rape of Lucrece*, in 1594. Shakespeare also dedicated this poem to the Earl of Southampton. The wording of the dedication suggests the possibility that the young nobleman had rewarded the author, probably financially, for his dedication in *Venus and Adonis*.

Both poems went through many editions during Shakespeare's lifetime. But their success did not lead Shakespeare to give up playwriting. After the public theatres were reopened in 1594, he began again to write plays. Indeed, Shakespeare was one of the few Elizabethan writers who concentrated almost solely on the theatre as a career.

The years of fame

From 1594 to 1608, Shakespeare was fully involved in the London theatre world. In addition to his duties as a shareholder and actor in the Lord Chamberlain's Men, he wrote an average of almost two plays a year for his company. During much of this period, Shakespeare ranked as London's most popular playwright, based on the number of times his plays were performed and published. But his reputation was largely that of a popular playwright, not of a writer of unequalled genius. Few people gave him the praise that later generations heaped on him. An exception was the English clergyman and schoolmaster Francis Meres.

In 1598, Meres wrote *Palladis Tamia: Wit's Treasury*, a book that has become an important source of information about Shakespeare's career. In this book, Meres said of Shakespeare: "As *Plautus* and *Seneca* are accounted the best for Comedy and Tragedy among the Latins; so *Shakespeare* among the English is the most excellent in both kinds for the stage." Although Meres' praise did not represent everyone's opinion, it indicates that Shakespeare had become an established writer by at least the late 1590's. And he had not yet written most of his great tragedies, such as *Hamlet*, *Othello*, *King Lear*, and *Macbeth*.

By the late 1590's, Shakespeare had not only become an established writer, but he had also become prosperous. In 1597, he purchased New Place, one of the two largest houses in Stratford. Shakespeare obviously remained a Stratford man at heart in spite of his busy, successful life in London. Records of business dealings and of minor legal action reveal that he preferred to invest most of his money in Stratford rather than in London.

The Globe Theatre. In 1599, Shakespeare and six associates became owners of the Globe, a new outdoor theatre in the London suburb of Southwark. The Globe was one of the largest theatres in the London area. It may have held as many as 3,000 spectators.

Also in 1599, a printer named William Jaggard published *The Passionate Pilgrim*, a book of 20 poems supposedly written by Shakespeare. However, the book contained only two of Shakespeare's sonnets and three poems from his comedy *Love's Labour's Lost*. The printer used Shakespeare's name on the title page to

promote the book's sale, which illustrates the playwright's popularity at that time.

The King's Men. In 1603, Queen Elizabeth I died and was succeeded by her cousin James VI of Scotland. As king of England, he became James I. James enjoyed and actively supported the theatre. He issued a royal licence to Shakespeare and his fellow players, which allowed the company to call itself the King's Men. In return for the licence, the actors entertained the king at court on a more or less regular basis.

James's support came at a convenient time. An outbreak of plague in 1603 had closed the theatres for long periods, making theatrical life uncertain. In fact, James's entry into London as king had to be postponed until 1604 because of the plague.

When James finally made his royal entry into London, the King's Men accompanied him. The members of the company were officially known as grooms of the chamber. In spite of this title and the name King's Men, the actors were not actually friends of the king. Their relationship to the royal court was simply that of professional entertainers.

The King's Men achieved unequalled success and became London's leading theatrical group. In 1608, the company leased the Blackfriars Theatre for 21 years. The theatre stood in a heavily populated London district called Blackfriars. The Blackfriars Theatre had artificial lighting, was probably heated, and served as the company's winter playhouse. The King's Men performed at the Globe during the summer.

The years 1599 to 1608 were a period of extraordinary literary activity for Shakespeare. During these years, he



A birthday celebration in Stratford honours Shakespeare each April 23, the traditional date of his birth. The celebration includes a procession that passes the Guild Chapel, with its stone tower, and the adjoining Stratford grammar school.

wrote several comedies and almost all the tragedies that have made him famous. Shakespeare's masterpieces during this period include the comedies *Much Ado About Nothing* and *Twelfth Night*; the history *Henry V*; and the tragedies *Antony and Cleopatra*, *Hamlet*, *Julius Caesar*, *King Lear*, *Macbeth*, and *Othello*.

The sonnets. In 1609, a London publisher named Thomas Thorpe published a book called *Shakespeare's Sonnets*. The volume contained more than 150 sonnets that Shakespeare had written over the years. Scholars have long been especially curious about the dedication Thorpe wrote to the book. The dedication reads, in modernized spelling: "To the only begetter of these ensuing sonnets Mr. W. H." Generations of researchers have failed to identify Mr. W. H. Scholars have also analysed the sonnets to determine to what extent they are autobiographical. But their analyses have proved contradictory and generally unsatisfactory. Many critics suggest that readers simply enjoy the sonnets as some of the finest verse in English literature instead of examining the poems as autobiographical statements. For additional information on the sonnets, see the section *Shakespeare's poems*.

His last years

During his last eight years of life, Shakespeare wrote only four plays—*Cymbeline*, *Henry VIII*, *The Tempest*, and *The Winter's Tale*. In the past, some scholars argued that *The Tempest*, written about 1610, was Shakespeare's last play. They stated that he then retired almost completely to Stratford. However, *Henry VIII* can be dated about 1613. In addition, Shakespeare purchased a house in the Blackfriars district of London in 1613. The evidence thus suggests that Shakespeare gradually reduced his activity in London rather than ending it abruptly.

Shakespeare must have divided his time between his private life in Stratford and his public life in London. He had lodgings in London at least until 1604 and probably until 1611. Yet such family events as his daughter Susanna's marriage in 1607 and his mother's death in 1608 would certainly have called him back to Stratford. By 1612, he may have been spending much of his time in the comforts of New Place in Stratford.

On Feb. 10, 1616, Shakespeare's younger daughter, Judith, married Thomas Quiney, the son of his Stratford neighbour Richard Quiney. Six weeks later, Shakespeare revised his will. Within a month, he died. He was buried inside the Stratford parish church. His monument records the day of death as April 23, the generally accepted date of his birth.

Shakespeare's son, Hamnet, died in 1596 at the age of 11. The playwright's daughter Susanna had one child, Elizabeth, who bore no children. Judith gave birth to three boys, but they died before she did. Shakespeare's last direct descendant, his granddaughter, Elizabeth, died in 1670.

The anti-Stratfordians

Through the years, the facts of Shakespeare's life have been confused with many tales based on hearsay and legend. During the 1800's in particular, admiration for



A statue of Shakespeare stands in Stratford's Holy Trinity Church, where the playwright is buried. Scholars consider this statue and the engraving reproduced on page 299 to be the only authentic likenesses of Shakespeare.

Shakespeare grew so intense that it resulted in a totally uncritical attitude toward the man and his works. This attitude made Shakespeare almost into a god.

Some people so admired Shakespeare's plays that they refused to believe an actor from Stratford-upon-Avon could have written them. Shakespeare's commonplace country background did not fit their image of the genius who wrote the plays. These people, called *anti-Stratfordians*, proposed several other Elizabethan writers as the author of Shakespeare's works. The writers they suggest are sometimes called *claimants*. Almost all the claimants were members of the nobility or upper class. The anti-Stratfordians believed that only an educated, sophisticated man of high social standing could have written the plays.

Sir Francis Bacon was the first and, for many years, the most popular candidate proposed as the real author of Shakespeare's plays. Bacon's followers remain active today. But other anti-Stratfordians have had their own favourites. Edward de Vere, the 17th Earl of Oxford, is now more popular than Bacon. Other men to whom authorship has been credited include Roger Manners, the 5th Earl of Rutland; William Stanley, the 6th Earl of Derby; and Sir Walter Raleigh. Some anti-Stratfordians have also claimed that the writer Christopher Marlowe was the actual author. In spite of the claims made for these men, no important Shakespearean scholar doubts that Shakespeare wrote the plays and poems.



Queen Elizabeth I and her court lived in Shakespeare's London much of the time, adding colour and excitement to the city's political and social life. This painting, completed about 1600 by an unknown artist, shows the queen and members of her court in a typical public appearance. Shakespeare's acting company performed many times before the queen and other nobles.

Shakespeare's works reflect the cultural, social, and political conditions of the Elizabethan Age. Knowledge of these conditions can provide greater understanding of Shakespeare's plays and poems. For example, most Elizabethans believed in ghosts, witches, and magicians. No biographical evidence exists that Shakespeare held such beliefs, but he used them effectively in his works. Ghosts play an important part in *Hamlet*, *Julius Caesar*, *Macbeth*, and *Richard III*. Witches are major characters in *Macbeth*. Prospero, the hero of *The Tempest*, is a magician.

Shakespeare's London had a population of nearly 200,000 in 1600. By modern standards, it was a crowded, unsanitary city. The unsanitary conditions led to frequent epidemics of plague, in which thousands of people died. Most houses were overcrowded, and the inner rooms dark and musty.

The crowded streets helped give London an air of bustling activity. But other factors also made London an exciting city. It was the commercial and banking centre of England and one of the world's chief trading centres. London was also the capital of England. The queen and her dazzling court thus lived in the city for much of each year, adding to the colour and excitement. The city's importance attracted people from throughout England and

from other countries. Artists, courtiers, teachers, musicians, students, and writers all flocked to London to seek advancement.

Although large for its day, London was still small enough so that a person could be close to its cultural and political life. The wide range of knowledge that Shakespeare showed in his plays has amazed many of his admirers. Yet much of this knowledge was the kind that could be absorbed by being in the company of informed persons. The range of Shakespeare's learning and the variety of his characters probably reflect his deep involvement in London life.

Elizabethan society. In the late 1500's, when Shakespeare began to write his plays, the English people tended to be optimistic. In 1588, the English navy won a great victory over the Armada, the huge Spanish fleet that tried to conquer England. The victory made England more secure and aroused strong feelings of patriotism. Following the triumph over the Armada, the English could agree with John of Gaunt in Shakespeare's *Richard II* that they were a "happy breed."

But the optimism of the late 1500's faded rapidly. By the time Queen Elizabeth died in 1603, the English were struggling with many social and economic problems. These problems were complicated by minor wars with

other countries—wars that often seemed without purpose. To many English people, the world appeared to be deteriorating and becoming, in Hamlet's words, "an unweeded garden / That grows to seed."

Shakespeare's plays reflect the shift from optimism to pessimism in Elizabethan society. All his early plays, even the histories and the tragedy *Romeo and Juliet*, have an exuberance that sets them apart from the later works. After 1600, Shakespeare's dramas show the confused, gloomy, and often bitter social attitudes of the time. During this period, he wrote his greatest tragedies. Even the comedies *Measure for Measure* and *All's Well That Ends Well* have a bitter quality not found in his earlier comedies. A character in the tragedy *King Lear* cries out in despair, "As flies to wanton boys are we to the gods. / They kill us for their sport." These lines reflect the uncertainties of the time, as well as the uncertainties of a particular dramatic situation.

Elizabethans were keenly aware of death and the brevity of life. They lived in constant fear of plague. When an epidemic struck, they saw victims carted off to common graves. Yet death and violence also fascinated many Elizabethans. Londoners flocked to public beheadings of traitors, whose heads were exhibited on poles. They also watched as criminals were hanged, and they saw the corpses dangle from the gallows for days. Crowds also flocked to such bloodthirsty sports as bear-baiting and bullbaiting, in which dogs attacked a bear or bull tied to a post.

Elizabethan literature mirrored the violence and death so characteristic of English life. Shakespeare's tragedies, like other Elizabethan tragedies, involve the murder or suicide of many of the leading characters.

In spite of their tolerance of cruelty, Elizabethans were extremely sensitive to beauty and grace. They loved many forms of literature, including poetic drama, narrative and lyric poetry, prose fiction, and essays. People of all classes enjoyed music, and English composers rivaled the finest composers in all Europe.

Instrumental music, singing, and dancing are important in Elizabethan drama. Some of Shakespeare's ro-

mantic comedies might almost be called "musical comedies." *Twelfth Night*, for example, includes instrumental serenades and rousing drinking songs as well as other songs ranging from sad to comic. Dances form part of the action in *The Tempest*, *The Winter's Tale*, and *Romeo and Juliet*.

The English ruler. Shakespeare's 10 history plays deal with English kings and nobility. Nine of the plays concern events from 1398 to the 1540's. A knowledge of these events and of the Elizabethans' attitude toward their own ruler can help a playgoer or reader understand Shakespeare's histories.

During the 100 years before Elizabeth I became queen, violent political and religious conflicts had weakened the throne. From 1455 to 1485, a series of particularly bitter civil wars tore England apart. The wars centered on the efforts of two rival noble families—the House of Lancaster and the House of York—to control the throne. The wars are called the Wars of the Roses because Lancaster's emblem was said to be a red rose and York's a white rose. Four of Shakespeare's historical plays deal with the Wars of the Roses. These plays, in historical order, are *Henry VI*, Parts I, II, and III; and *Richard III*.

During the early 1500's, England was divided by a religious struggle. In 1534, Henry VIII broke with the Roman Catholic Church. His action led to the formation of the Church of England. In 1553, Queen Mary I reestablished Catholicism as the state religion. But after Elizabeth I became queen in 1558, she reestablished the Church of England.

As a result of the preceding 100 years of conflict, Elizabethans came to believe that a strong but just ruler was absolutely necessary to keep social order. In seeing Shakespeare's history plays, they would have understood his treatment of royal responsibilities as well as royal privileges. Elizabethans would have been aware of the dangers of a weak king—dangers that Shakespeare described in *Richard II*. They would also have been alert to the dangers of a cruel and unjust ruler, which Shakespeare portrayed in *Richard III*.



A belief in witches was common in Shakespeare's time. The playwright used witches as major characters in his tragedy *Macbeth*. This woodcut shows Macbeth and his friend Banquo meeting three witches on a lonely road. The illustration appeared in the *Chronicles* by the English historian Raphael Holinshed. Shakespeare used Holinshed's book as a basic source for *Macbeth* and many other plays.

Shakespeare wrote his plays to suit the abilities of particular actors and the tastes of specific audiences. The physical structure of the theatres in which his works were presented also influenced his playwriting. He used many dramatic devices that were popular in the Elizabethan theatre but are no longer widely used. Modern readers and theatre-goers can enjoy Shakespeare's plays more fully if they know about the various theatrical influences that helped shape them.

Theatre buildings. By the late 1500's, Elizabethan plays were being performed in two kinds of theatre buildings—later called *public* and *private* theatres. Public theatres were larger than private ones and held at least 2,500 people. They were built around a courtyard that had no roof. Public theatres gave performances only during daylight hours because they had no artificial lights. Private theatres were smaller, roofed structures. They had candlelight for evening performances. Private theatres charged higher prices and were designed to attract upper-class patrons. Because Shakespeare wrote most of his plays for public theatres, this section deals chiefly with the design and structure of such buildings.

In 1576, James Burbage built England's first successful public theatre, called simply *The Theatre*. It stood in a suburb north of London, outside the strict supervision of London government authorities. Soon other public theatres were built in the London suburbs. These theatres included the *Curtain*, the *Rose*, and the *Swan*. In 1599, Shakespeare and his associates built the *Globe Theatre*. Detailed evidence of how the Elizabethan public theatres looked is limited. But scholars have been able to reconstruct the general characteristics of a typical public theatre.

The structure that enclosed the courtyard of a public theatre was round, square, or many-sided. In most theatres it probably consisted of three levels of galleries and stood about 10 metres high. The courtyard, called the

pit, measured about 17 metres in diameter. The stage occupied one end of the pit. For the price of admission, the poorer spectators, called *groundlings*, could stand in the pit and watch the show. For an extra fee, wealthier patrons could sit on benches in the galleries.

The stage of a public theatre was a large platform that projected into the pit. This arrangement allowed the audience to watch from the front and sides. The performers, nearly surrounded by spectators, thus had close contact with most of their audience.

Actors entered and left the stage through two or more doorways at the back of the stage. Behind the doorways were *tiring* (dressing) rooms. At the rear of the stage, there was a curtained *discovery* space. Scholars disagree about the details of this feature. But the space could be used to "discover"—that is, reveal—one or two characters by opening the curtains. Characters could also hide there or eavesdrop on conversations among characters up front on the main stage. The gallery that hung over the back of the main stage served as an upper stage. It could be used as a balcony or the top of a castle wall. The upper stage allowed Elizabethan dramatists to give their plays vertical action in addition to the usual horizontal movement. Some theatres may have had a small third level room to accommodate musicians.

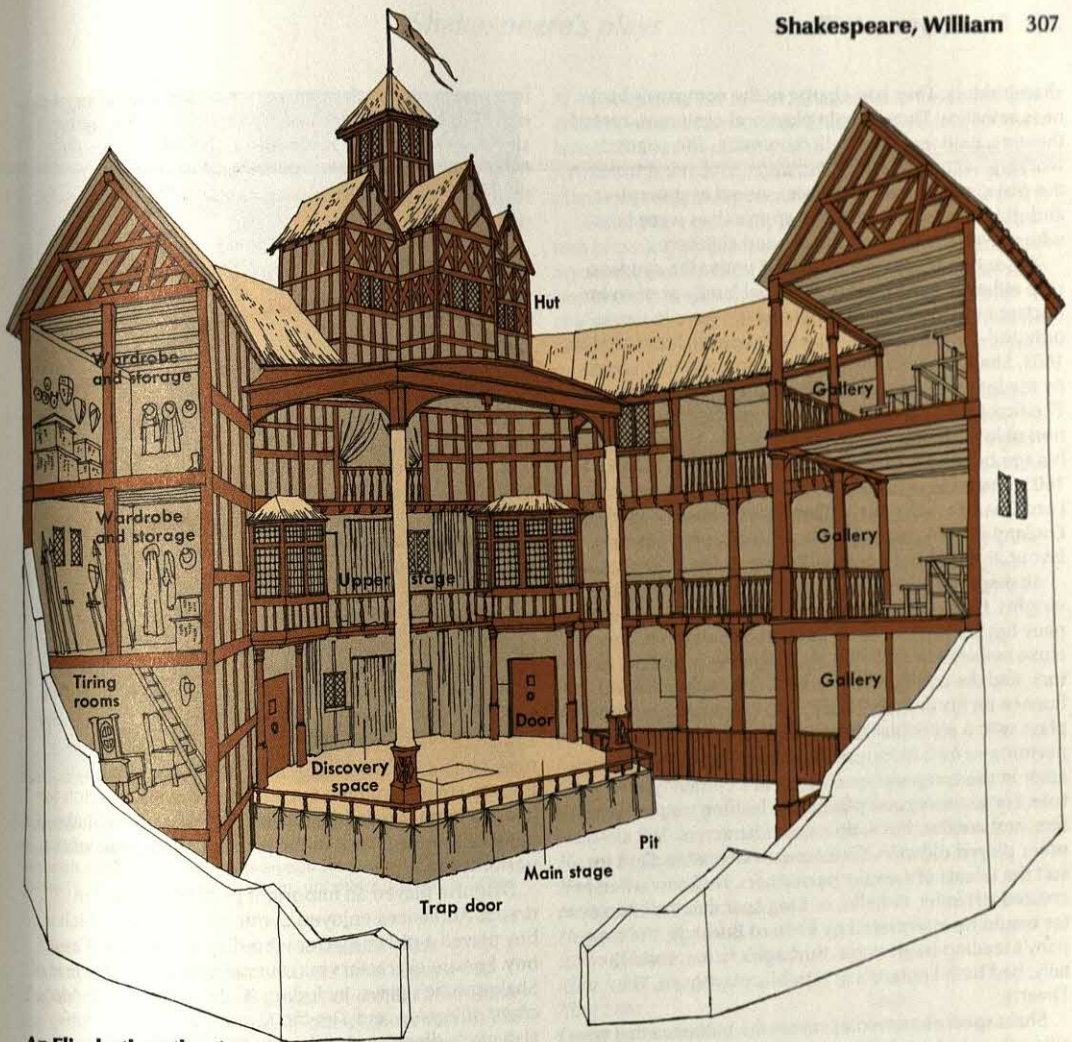
A half roof projected over the upper stage and the back part of the main stage. Atop the roof was a hut that contained machinery to produce sound effects and various special effects, such as the lowering of an actor playing a god. The underside of the hut was sometimes called the *heavens*. Two pillars supported the structure. The underside of the heavens was richly painted, and the interior of the theatre undoubtedly had a number of other decorative features.

The main stage had a large trap door. Actors playing the parts of ghosts and spirits could rise and disappear

Detail of *Long View of London* (1616), an engraving by Claes Jansz Visscher; British Museum, London



The Globe Theatre became the home of Shakespeare's acting company in 1599. It stood near the south bank of the River Thames in the London suburb of Southwark. The Globe is the many-sided building in the lower centre of this illustration. A similar structure to the left is the Hope Theatre, sometimes called the Bear Garden.



An Elizabethan theatre

This illustration shows the general appearance of an Elizabethan public theatre. The buildings were round, square, or many-sided. All were open at the top. Spectators stood in the pit or sat in the galleries. Actors performed on the main stage, in the discovery space, and on the upper stage. The hut atop the roof contained machinery to produce sound effects and various special effects.

through the door. The trap door, when opened, could also serve as a grave.

Scenic effects. Unlike most modern dramas, Elizabethan plays did not depend on scenery to indicate the *setting* (place) of the action. Generally, the setting was unknown to the audience until the characters identified it with a few lines of dialogue. In addition, the main stage had no curtain. One scene could follow another quickly because there was no curtain to close and open and no scenery to change. The lack of scenery also allowed the action to flow freely from place to place, as in modern films. The action of Shakespeare's *Antony and Cleopatra*, for example, shifts smoothly and easily back and forth between ancient Egypt and Rome.

Although the stage lacked scenery, various *props* were used, such as thrones, swords, banners, rocks, trees, tables, and beds. *Richard III* calls for two tents, one at each end of the stage.

Costumes and sound effects. The absence of scenery did not result in dull or drab productions. Acting companies spent much money on colourful costumes, largely to produce visual splendour. Flashing swords and swirling banners also added colour and excitement.

Sound effects had an important part in Elizabethan drama. Trumpet blasts and drum rolls were common. Sometimes unusual sounds were created, such as "the noise of a sea-fight" called for in *Antony and Cleopatra*. Music also played a vital role. Shakespeare filled *Twelfth Night* with songs. In *Antony and Cleopatra*, the playwright included mysterious-sounding chords to set the mood before a fatal battle.

Acting companies consisted of only men and boys because women did not perform on the Elizabethan stage. A typical acting company had 8 to 12 sharers, a number of salaried workers, and apprentices. The sharers were the company's leading actors as well as its

shareholders. They had charge of the company's business activities. They bought plays and costumes, rented theatres, paid fees, and split the profits. The salaried workers, who were called *hirelings*, took minor roles in the plays, performed the music, served as prompters, and did various odd jobs. The apprentices were boys who played the roles of women and children.

The acting companies operated under the sponsorship either of a member of the royal family or of an important nobleman. Most sponsorships were in name only and did not include financial support. From 1594 to 1603, Shakespeare's company was sponsored, in turn, by the first and second Lord Hunsdon, a father and son. The first Lord Hunsdon held the important court position of lord chamberlain until he died in 1596. In 1597, his son became lord chamberlain. Thus from 1594 to 1603, Shakespeare's company was mostly known as the Lord Chamberlain's Men. After James I became king of England in 1603, he singled out the company for royal favour. It was then known as the King's Men.

Shakespeare was unusual among Elizabethan playwrights. He not only wrote exclusively for his own company but also served as an actor and sharer in it. The close association between Shakespeare, his fellow actors, and the conditions of production had enormous influence on his dramas. Shakespeare wrote most of his plays with a particular theatre building in mind and for performers he had frequently acted with. Each major actor in the company specialized in a certain type of role. For example, one played the leading tragic characters, and another the main comic characters. Still another played old men. Shakespeare wrote his plays to suit the talents of specific performers. He knew when he created a Hamlet, Othello, or King Lear that the character would be interpreted by Richard Burbage, the company's leading tragic actor. Burbage's father, incidentally, had built England's first public playhouse, The Theatre.

Shakespeare's comedies reveal the influence that specific actors had on the creation of his plays. From 1594 to 1599, the company's leading comic actor was Will Kempe. During this time, Shakespeare's chief comic characters reflected the broad humour of Kempe, who was known for his vaudeville style of singing and dancing. Shakespeare wrote such lively comedies as *A Midsummer Night's Dream* and *Much Ado About Nothing* with Kempe in mind. After Kempe left the company, Robert Armin took his place, and the style of Shakespeare's comedy shifted noticeably. The playwright skillfully used Armin's more sophisticated and intellectual comic talents in such lively but thoughtful comedies as *Twelfth Night* and *As You Like It*.

Elizabethan acting companies required plays that had roles for all the major performers. Partly for this reason, comic scenes appear in even the most violent of Shakespeare's tragedies. Many of these scenes were included simply to give the company's leading comic actor a role. The first gravedigger in *Hamlet* and the porter in *Macbeth* are comic characters in Shakespeare's tragedies.

Scholars still debate the exact nature of Elizabethan acting style. Yet Elizabethan actors probably performed much as actors do today. However, they spoke their

lines more rapidly than modern performers do. In addition, Elizabethan actors had an especially clear and musical speaking style. This method of speaking developed from years of acting experience and from the Elizabethan love for the musical possibilities of the English language.

Dramatic conventions. The writing and staging of Elizabethan plays were strongly influenced by various dramatic *conventions* (customs) of that time. The most widespread convention was the use of poetic dialogue. Although Shakespeare's plays contain prose and rhymed verse, he chiefly used an unrhymed, rhythmical form of poetry called *blank verse*.

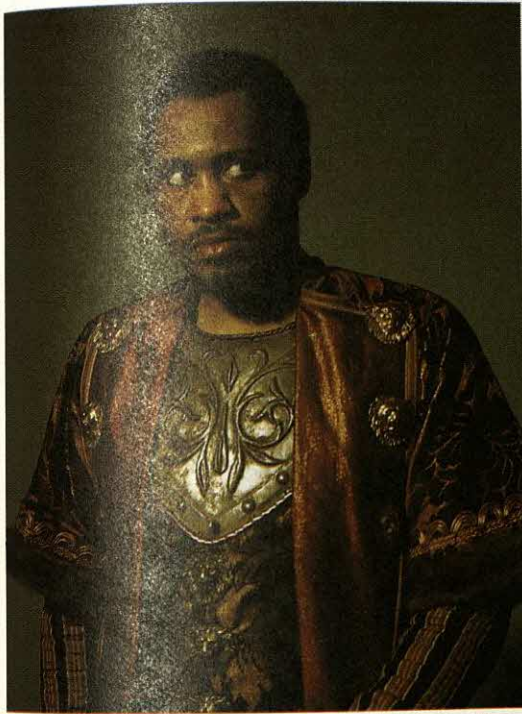
Two common conventions that audiences expected were *soliloquies* and *asides*. In a soliloquy, an actor, who is alone on the stage, recites a speech directly to the audience. Or he speaks aloud to himself his thoughts and feelings. In an aside, a character speaks words that the other characters onstage are not supposed to hear. Audiences also liked and expected long lyrical speeches. Many of these speeches had little direct relation to the play's action. Mercutio's "Queen Mab" speech in *Romeo and Juliet* is a famous example.

The convention of boy apprentices playing women's roles contributed directly to some of Shakespeare's finest writing. The "boy actresses" were thoroughly trained and highly skilled. But Shakespeare had to rely on the magic of his verse rather than the loveliness of an actress to create feminine appeal. The "Beauty too rich for use, for earth too dear" of Juliet lay primarily in Shakespeare's language, not in the physical attractions of the performer.

Disguise played an important part in Elizabethan drama. Audiences enjoyed comic situations in which a boy played a girl character who disguised herself as a boy. Female characters masquerade as men in several of Shakespeare's plays, including *As You Like It*, *The Merchant of Venice*, and *Twelfth Night*. Social conditions also made disguise an effective theatrical device in Elizabethan times. The Elizabethans recognized sharp distinctions between social classes and between occupations. These distinctions were emphasized by striking differences in dress. Noblemen were immediately recognized by their clothing, as were doctors, lawyers, merchants, or pages. Characters could thus easily disguise themselves by wearing the garments of a certain social class or occupation.

Shakespeare's audiences. Shakespeare wrote most of his plays for audiences with a broad social background. To the Globe Theatre came a cross section of London society, ranging from apprentices playing truant from work to members of the nobility passing the time. But most of the Globe's audience consisted of middle-class citizens, such as merchants and craftsmen and their wives. They went to the theatre for the same reasons most people today go to the cinema—to relax and to escape for a while from their cares.

Shakespeare's plays were also produced at the royal court, in the houses of noblemen, and sometimes in universities and law schools. For most of his career, he thus wrote plays that had to appeal to people of many backgrounds and tastes.



Othello was written during Shakespeare's third period, when he created his greatest tragedies. It concerns Othello, a black Moorish general, who marries a younger woman, Desdemona. Tricked into believing she has been unfaithful, Othello kills her.

Most scholars agree that there exist 37 plays by Shakespeare. A number of scholars have argued that Shakespeare also wrote all or part of certain other existing or lost plays. However, only one of these works, *The Two Noble Kinsmen*, has gained any acceptance. Many scholars believe that Shakespeare wrote the play with another English dramatist, John Fletcher. But most scholars omit this work from the accepted list of Shakespeare's dramas.

Much Shakespearean research has been devoted to determining the order in which Shakespeare's plays were written and first performed. The Elizabethans kept no records of premieres of plays, and no newspapers existed to provide opening-night reviews. All Shakespeare's known plays were eventually published, but the publication date is not necessarily the date of a play's composition or premiere.

To establish the order in which Shakespeare's plays were probably written and first performed, scholars have relied on a variety of literary and historical evidence. This evidence includes records of performances, mention of Shakespeare's works by other Elizabethan writers, and references in Shakespeare's plays to events of the day. Scholars can also roughly date a play by Shakespeare's literary style. But for many of the plays, precise dates remain uncertain.

Traditionally, Shakespeare's plays have been divided into three groups—comedies, histories, and tragedies.

At each stage of his career, Shakespeare tended to concentrate on a certain kind of drama, depending on the tastes of his audience at that time. For example, he wrote 9 of his 10 histories during a period when such plays were especially popular.

Shakespeare generally followed the Elizabethan custom of basing his plots on published historical and literary works. But he differed from most other dramatists in one important way. In retelling a story, Shakespeare shaped the borrowed material with such genius that he produced a work of art that was uniquely different from its source.

This section describes the plots and notable characteristics of all Shakespeare's plays. The plays have been divided into four periods, each of which reflects a general phase of Shakespeare's artistic development. Within each period, the plays are discussed in the order in which they were probably first performed.

For readers interested in a specific play or plays, the following table lists the plays alphabetically and gives the period in which a description of each play may be found.

Play	Period
<i>All's Well That Ends Well</i>	Third
<i>Antony and Cleopatra</i>	Third
<i>As You Like It</i>	Second
<i>Comedy of Errors, The</i>	First
<i>Coriolanus</i>	Third
<i>Cymbeline</i>	Fourth
<i>Hamlet</i>	Third
<i>Henry IV, Parts I and II</i>	Second
<i>Henry V</i>	Second
<i>Henry VI, Parts I, II, and III</i>	First
<i>Henry VIII</i>	Fourth
<i>Julius Caesar</i>	Second
<i>King John</i>	First
<i>King Lear</i>	Third
<i>Love's Labour's Lost</i>	Second
<i>Macbeth</i>	Third
<i>Measure for Measure</i>	Third
<i>Merchant of Venice, The</i>	Second
<i>Merry Wives of Windsor, The</i>	Second
<i>Midsummer Night's Dream, A</i>	Second
<i>Much Ado About Nothing</i>	Third
<i>Othello</i>	Third
<i>Pericles</i>	Third
<i>Richard II</i>	Second
<i>Richard III</i>	First
<i>Romeo and Juliet</i>	Second
<i>Taming of the Shrew, The</i>	First
<i>Tempest, The</i>	Fourth
<i>Timon of Athens</i>	Third
<i>Titus Andronicus</i>	First
<i>Troilus and Cressida</i>	Third
<i>Twelfth Night</i>	Second
<i>Two Gentlemen of Verona, The</i>	First
<i>Winter's Tale, The</i>	Fourth

The first period (1590-1594)

The plays of Shakespeare's first period have much in common, though they consist of comedies, histories,

and a tragedy. The plots of these plays tend to follow their sources more mechanically than do the plots of Shakespeare's later works. The plots also tend to consist of a series of loosely related episodes, rather than a closely integrated dramatic structure. In addition, the plays generally emphasize events more than the portrayal of character.

In his first period, Shakespeare's use of language indicates that he was still struggling to develop his own flexible poetic style. For example, Shakespeare's descriptive poetry in this period is apt to be flowery, rather than directly related to the development of the characters or the story.

The Comedy of Errors, a comedy partly based on *Amphitruo* and *Menaechmi*, two comedies by the ancient Roman playwright Plautus. Probably first performed during the period from 1590 to 1594. First published in 1623.

The action in *The Comedy of Errors* takes place in the ancient Greek city of Ephesus. The plot deals with identical twin brothers, both named Antipholus. Each brother has a servant named Dromio, who also happen to be twin brothers. The twins of each set were separated as children, and neither twin knows where his brother is living. One twin and his servant live in Ephesus. Their brothers live in Syracuse. After Antipholus and Dromio of Syracuse arrive in Ephesus, a series of mistaken identities and comical mix-ups develops before the twin brothers are reunited.

The Comedy of Errors has little character portrayal or fine poetry. However, the plot is filled with intrigue and broad humour, which make the play highly effective theatre.

Henry VI, Parts I, II, and III, three related histories partly based on *The Union of the Two Noble and Illustrious Families of Lancaster and York* by the English historian Edward Hall and on the *Chronicles* by the English historian Raphael Holinshed. Each part probably first performed during the period from 1590 to 1592. Part I published in 1623, Part II in 1594, and Part III in 1595.

The three parts of *Henry VI* present a panoramic view of English history in the 1400s. The action begins with the death of King Henry V in 1422. It ends with the Battle of Tewkesbury in 1471. The plays vividly mirror the Wars of the Roses—the series of bloody conflicts between the houses of York and Lancaster for control of the English throne. Part I deals largely with wars between England and France. But all three plays dramatize the plots and counterplots that marked the struggle between the two royal houses.

The *Henry VI* plays are confusing to read because of their large and shifting casts of characters. The plays have much greater impact when performed than when read. On the stage, the constant action, exaggerated language, and flashes of brilliant characterization result in lively historical drama.

Richard III, a history partly based on *The Union of the Two Noble and Illustrious Families of Lancaster and York* by the English historian Edward Hall and on the *Chronicles* by the English historian Raphael Holinshed. Probably first performed in 1593. First published in 1597.

The play deals with the end of the Wars of the Roses.

It opens with the hunchbacked Richard, Duke of Gloucester, confiding his villainous plans to the audience. He addresses the audience in a famous soliloquy that begins, "Now is the winter of our discontent/ Made glorious summer by this sun of York." Richard refers to the success of his brother Edward, Duke of York. Edward has overthrown Henry VI of the House of Lancaster and taken the English throne. Now weak and ill, he rules England as Edward IV. Richard wants to gain the crown for himself. He has his other brother, the Duke of Clarence, murdered. After King Edward dies, Richard sends the Prince of Wales, the dead king's older son, and the prince's brother to the Tower of London. After seizing the throne as Richard III, he has the two boys murdered.

Before long, Richard's allies turn against him and join forces with the Earl of Richmond, a member of the House of Lancaster. Richmond's forces defeat Richard's army at the Battle of Bosworth Field. Richard utters the famous cry "A horse! a horse! my kingdom for a horse!" as his mount is slain during the battle. Richmond finally kills Richard and takes the throne as King Henry VII.

The character of Richard is a superb theatrical portrait of total evil. But Richard blends his wickedness with such wit that his plotting becomes a delight to watch. On a deeper level, *Richard III* reminds audiences that when evil flourishes, society in general is to blame. People can be freed from the evil around them only when they themselves live up to the demands they make of their leaders.

The Taming of the Shrew, a comedy possibly based on *The Taming of a Shrew*, a comedy by an unknown English playwright, and on *Supposes*, a comedy by the English author George Gascoigne. Probably first performed in 1593. First published in 1623.

This play dramatizes how Petruchio, a young Italian gentleman, woos the beautiful but *shrewish* (bad-tempered) Katherine, whose biting tongue has discouraged other suitors. Petruchio marries her. But before and after the wedding, he systematically humiliates Katherine to cure her of her temper. After many comical clashes between the two, Petruchio's strategy succeeds and Katherine becomes an obedient wife. At this point, Petruchio reveals himself to be a true gentleman and genuinely fond of Katherine.

A broad and vigorous comedy, *The Taming of the Shrew* provides two outstanding roles in the characters of the battling lovers. The parts of Petruchio and Katherine have been a showcase for generations of gifted actors and actresses.

Titus Andronicus, a tragedy possibly based in part on *The History of Titus Andronicus*, a story by an unknown English author. Probably first performed about 1594. First published in 1594.

This play is a type of melodrama that was popular in Elizabethan theatre. The action takes place in and around ancient Rome. It involves a series of brutal acts of revenge by the Roman general Titus Andronicus against the men who raped his daughter, Lavinia. Shakespeare only occasionally lightened the play's bloody sensationalism with effective poetry and characterization. The evil plots of Aaron the Moor provide most



Titus Andronicus is a tragedy of revenge by Roman general Titus against the men who raped his daughter, Lavinia.

of the interest in an otherwise continuous parade of horror and violence.

The Two Gentlemen of Verona, a comedy partly based on *Diana*, a story by the Spanish author Jorge de Montemayor, and on *The Book of the Governor*, an educational work by the English author Sir Thomas Elyot. Probably first performed in 1594. First published in 1623.

The play is a witty comedy of love and friendship. It takes place in Italy. Two friends from Verona, Valentine and Proteus, meet in Milan. They soon become rivals for the love of Silvia, the daughter of the Duke of Milan. Valentine discovers Proteus as his friend is about to force his attentions on Silvia. Proteus repents his action, and Valentine forgives him. Valentine then tells his friend that he can have Silvia. But Valentine's generosity becomes unnecessary. Proteus learns that Julia, his former mistress, has followed him to Milan disguised as a page. Proteus realizes that he really loves Julia. He marries her at the end of the play, and Valentine marries Silvia.

In *The Two Gentlemen of Verona*, Shakespeare introduced several features and devices that he later used so effectively in the great romantic comedies of his second period. For example, he included beautiful songs, such as "Who Is Silvia?"; scenes in a peaceful, idealized forest; and a girl, disguised as a page, braving the dangers of the world.

King John, a history probably based in part on *The Troublesome Reign of John, King of England*, a play by an unknown English author. Probably first performed about 1594. First published in 1623.

The story concerns the efforts of England's King John to defend his throne against the claims of Arthur, the

young Duke of Brittany. The powerful king of France supports Arthur. John has the allegiance of the brave and able Philip Faulconbridge and of the English nobility. But in time, John's evil and weak policies cost him the loyalty of his followers. Near the end of the play, both Arthur and John die violently. John's son then takes the throne as Henry III.

The most interesting character in *King John* is Faulconbridge. His sarcastic and witty comments on the personalities and motives of the other characters provide the play's best dialogue.

The second period (1595-1600)

During his second period, Shakespeare brought historical drama and Elizabethan romantic comedy to near perfection. Particularly in his histories and comedies of this period, Shakespeare demonstrated his genius for weaving various dramatic actions into a unified plot, rather than writing a series of loosely connected episodes. Throughout the second period, Shakespeare moved steadily toward the matchless gift for characterization that marks the great tragedies he produced in the early 1600's.

A Midsummer Night's Dream, a comedy probably based on several sources, none of which was a chief source. Probably first performed in 1595. First published in 1600.

The play begins in Athens, Greece, with preparations for a wedding between Theseus, Duke of Athens, and Hippolyta, queen of the Amazons. But most of the action takes place in an enchanted forest outside Athens. In the forest, two young men, Lysander and Demetrius, and two young women, Hermia and Helena, wander about together after they become lost. Lysander and Demetrius both love Hermia and ignore Helena, who loves Demetrius. Oberon, king of the fairies, orders the mischievous elf Puck to anoint Demetrius' eyes with magic drops that will make him love Helena. However, Puck mistakenly anoints Lysander's eyes, creating much comic confusion. Puck finally straightens out the mix-up.

In a subplot, Oberon quarrels with Titania, his queen. He then anoints Titania's eyes with the magic drops while she sleeps so that when she awakens, she will love the first living thing she sees. At this time, Nick Bottom, a weaver, and his comical friends are rehearsing a foolish play they plan to present at the duke's wedding. When Titania awakens, she sees Bottom and immediately falls in love with him. To increase Titania's humiliation, Puck gives Bottom the head of a donkey. Aided by her fairy attendants, Titania woos Bottom until Oberon takes pity on her and has Puck remove the spell. The play ends with the duke's wedding. The two young couples—Lysander and Hermia and Demetrius and Helena—also marry during this ceremony. Bottom and his friends perform their hilariously silly play at the wedding celebration.

For *A Midsummer Night's Dream*, Shakespeare wrote some of his most richly descriptive poetry. Oberon tells Puck, "I know a bank where the wild thyme blows / Where oxlips and the nodding violet grows." The passage transports the audience in imagination to a magic wood where flowers bloom and fairies play. Shakespeare balanced this romantic fantasy with the rough humour of Bottom and his friends. The self-centred Bot-

tom ranks as one of Shakespeare's finest comic figures. The comedy also has a serious side. Gaily but firmly, it makes fun of romantic love. As Puck comments, "Lord, what fools these mortals be!"

Richard II, a history partly based on the *Chronicles* by the English historian Raphael Holinshed. Probably first performed in 1595. First published in 1597.

As the play begins, King Richard exiles his cousin Bolingbroke from England. Later, Richard seizes Bolingbroke's property. While Richard fights rebels in Ireland, Bolingbroke returns to England and demands his property. After Richard learns of Bolingbroke's return, he hurries back to England to find his cousin leading a force of nobles who are discontented with Richard's rule. Instead of preparing the royal army to fight Bolingbroke, Richard wastes his time in outbursts of self-pity. He finally gives up his crown to Bolingbroke without a fight. Bolingbroke then orders that Richard be put in prison.

After Bolingbroke is crowned Henry IV, the imprisoned Richard is killed by a knight who mistakenly believed that the new king wanted Richard murdered. At the end of the play, Henry vows to make a journey to the Holy Land to pay for Richard's death.

In *Richard II*, Shakespeare seriously explored for the first time the idea that a person's character determines his fate. The play is a study of a weak, self-centred man. Richard becomes so out of touch with reality that his only defence of his kingdom is the hope that his "master, God omnipotent, / Is mustering in his clouds on our behalf / Armies of pestilence." When he faces the certain loss of his crown, Richard can only compare himself to Christ, who "in twelve, / Found truth in all but one; I, in twelve thousand none."

Love's Labour's Lost, a comedy probably based on several sources, none of which was a chief source. Probably first performed in 1596. First published in 1598.

King Ferdinand of Navarre and his friends Berowne, Longaville, and Dumain vow to live without the company of women for three years. But the princess of France unexpectedly arrives at the king's court with three female companions. The comedy centres on the

efforts of the men to woo the women while pretending to keep their vow. At the play's end, the men propose to their visitors, who promise to give their answer in a year and a day.

This witty comedy has more references to events of the day than do any of Shakespeare's other plays. Many of these references have lost their meaning for modern audiences, which makes numerous passages difficult to understand. In addition, much of the language is elaborate and artificial. But Shakespeare included two simple and lovely songs—"When Daisies Pied and Violets Blue" and "When Icicles Hang by the Wall." *Love's Labour's Lost* also has handsome scenes of spectacle and several entertaining comic characters.

Romeo and Juliet, a tragedy based on *Romeus and Juliet*, a poem by the English author Arthur Brooke. Probably first performed in 1596. First published in 1597.

Romeo and Juliet deals with two teenaged lovers in Verona, Italy, who are caught in a bitter feud between their families, the Montagues and the Capulets. Romeo, a Montague, and his friends are uninvited guests at a masked ball given by the Capulets. At the ball, Romeo meets Juliet, a Capulet, and they fall in love. The next day, the couple are secretly married by Friar Laurence. Returning from the wedding, Romeo meets Juliet's cousin Tybalt, who tries to pick a fight with him. But Romeo refuses to fight his new relative. To defend the Montague honour, Romeo's friend Mercutio accepts Tybalt's challenge. As Romeo attempts to part the young men, Tybalt stabs Mercutio to death. In revenge, Romeo then fights and kills Tybalt. As a result of the death of Tybalt, Romeo is exiled from Verona.

Juliet's father tries to force her to marry her cousin Paris, unaware that she is already married. To allow Juliet to escape from her father's demand, Friar Laurence gives Juliet a drug that puts her into a deathlike sleep for 42 hours. The friar sends a messenger to the exiled Romeo to tell him of the drug, but the messenger is delayed. Romeo hears that Juliet is dead and hurries to the tomb where she has been placed. There, he takes poison and dies by Juliet's side. Juliet awakens to find her husband dead and stabs herself. The discovery of the



A Midsummer Night's Dream is a comedy that mixes realistic humour with scenes involving fairies and enchanted lovers. The Royal Shakespeare Company gained acclaim for its imaginative interpretation of the play. This scene from the company's production shows fairies singing Titania, their queen, to sleep.



Romeo and Juliet is a tragedy of lasting popularity in which Shakespeare clearly sympathizes with the lovers and not the self-interested adults. In this production, Ewen Cummings, *left*, plays Benvolio and David Harewood, *right*, plays Romeo.

dead lovers convinces the two families that they must end their feud.

The popularity of *Romeo and Juliet* owes much to Shakespeare's sympathy for the young people in the play. Shakespeare seemed to blame the tragic ending on the blind self-interest of the adults. The success of the play also comes from effective characterizations and intensely lyrical poetry. Although frequently artificial, Shakespeare's language shows signs of the simpler, more direct style he would use in his later tragedies. For example, as Romeo watches Juliet on the balcony outside her bedroom, he sighs:

See how she leans her cheek upon her hand!
Oh, that I were a glove upon that hand,
That I might touch that cheek!

The Merchant of Venice, a comedy partly based on a story in *Il Pecorone*, a collection of tales by the Italian author Giovanni Fiorentino. Probably first performed in 1597. First published in 1600.

Antonio, a merchant in Venice, Italy, borrows money from the Jewish moneylender Shylock and then lends the money to his friend Bassanio. Antonio has promised Shylock a pound of his flesh if he does not repay the loan in three months. The three months pass, and Shylock demands his money. But Antonio cannot pay. Shylock then demands the pound of flesh.

Meanwhile, Bassanio has courted and married the beautiful and gifted heiress Portia. She has a plan to save Antonio from Shylock. Shylock goes to court to demand the flesh. Portia, disguised as a learned lawyer, asks him to reconsider in a famous speech that begins, "The quality of mercy is not strained." Shylock remains firm. Portia then warns him that he may take Antonio's flesh but not his blood. If Shylock spills any blood in taking the flesh, he will lose his property. Shylock drops his demand, and Antonio is saved.

In *The Merchant of Venice*, Shakespeare combined comic intrigue with a vivid portrait of hatred and greed.

Although the play ends happily for everyone except the revengeful Shylock, it is not a light-hearted comedy. In Shakespeare's time, both the church and the state considered moneylending at high interest a crime. Shylock was thus a natural object of scorn. On the surface, Shakespeare's view of him reflected the attitudes of the day. But the dramatist treated the moneylender as a very human and even sympathetic person. For example, Shakespeare provided Shylock with an eloquent statement of how it feels to be part of a harshly treated minority: "If you prick us, do we not bleed? If you tickle us, do we not laugh? If you poison us, do we not die? And if you wrong us, shall we not revenge?"

Henry IV, Parts I and II, two related histories partly based on the *Chronicles* by the English historian Raphael Holinshed and on *The Famous Victories of Henry the Fifth*, a play by an unknown English author. Part I probably first performed in 1597. First published in 1598. Part II probably first performed in 1598. First published in 1600.

The two parts of *Henry IV* dramatize events that follow the murder of England's King Richard II. In Part I, the guilt-ridden Henry IV wants to go to the Holy Land in repentance for Richard's death. But constant political unrest in England prevents him. At the same time, Prince Hal, his son, leads an apparently irresponsible life with his brawling friends, led by the fat, jolly knight Sir John Falstaff. Falstaff's clowning provides most of the play's humour. The king quarrels with Henry Percy, known as Hotspur, who is the fiery young son of the powerful Earl of Northumberland. As a result of the quarrel, the Percy family revolts. At the Battle of Shrewsbury, Hal reveals himself to be a brave and princely warrior and kills Hotspur.

Part II of *Henry IV* also has many scenes of Falstaff's clowning. These scenes are set against the background of the continuing Percy rebellion and the approaching death of the ill Henry IV. Hal's brother, Prince John, finally defeats the rebels. The king dies, and Hal takes the



Henry IV, a two-part history, is noted for the character of Sir John Falstaff, one of Shakespeare's greatest comic figures. In the plays, Falstaff, *right*, spends much of his time drinking and clowning with his boisterous friends at the Boar's Head Inn.

throne as Henry V. He immediately reveals his royal qualities and rejects Falstaff and his friends, telling them to leave him alone until they have abandoned their wild living.

Of the two plays, Part I is more memorable. It introduces Falstaff, best characterized by his comment in Part II that "I am not only witty in myself, but the cause that wit is in other men." Falstaff is a bragging, lying, and thievish drunkard. But his faults are balanced by his clever sense of humour, his contagious love of life, and his refusal to take either himself or the world seriously. Falstaff is one of the great comic roles in the theatre.

As You Like It, a comedy partly based on *Rosalynde*, a novel by the English author Thomas Lodge. Probably first performed in 1599. First published in 1623.

Rosalind and her cousin Celia leave the court of Celia's father, Duke Frederick, after he unjustly banishes Rosalind. Accompanied by Touchstone, the court jester, the two girls take refuge in the Forest of Arden. Also in the forest are Orlando, who loves Rosalind; Jaques, a melancholy philosopher; Audrey, a country girl; Silvius, a shepherd; and Phebe, a shepherdess. Duke Frederick's brother, who is Rosalind's father and the rightful ruler of Frederick's land, also lives in the forest. He leads a band of merry outlaws.

Rosalind, disguised as a young shepherd named Ganymede, meets Orlando in the forest. Not recognizing the disguised girl, Orlando agrees to pretend that Ganymede is Rosalind so he can practise his declarations of love. Rosalind finally reveals her identity and marries Orlando. Oliver, Orlando's formerly wicked brother, marries Celia, Touchstone marries Audrey, and Silvius marries Phebe. The news that Rosalind's father has been restored to his dukedom completes the comedy's happy ending.

Like many other Elizabethan romantic comedies, *As You Like It* concerns young lovers who pursue their happy destiny in a world seemingly far removed from reality. Although evil threatens, it never harms. Shake-

speare enriched the play with beautiful poetry as well as several charming songs.

Shakespeare consistently balanced the merry laughter of *As You Like It* with notes of seriousness and even sadness. Touchstone's wit and Jaques's remarks question the nature of love and the values of society. The play discusses the advantages and disadvantages of city and country life. Jaques adds a strong note of melancholy to the play with his famous description of the seven ages of man. At the end of the description, he claims that man's final fate is "second childishness and mere oblivion, / Sans (without) teeth, sans eyes, sans taste, sans everything."

Henry V, a history partly based on the *Chronicles* by the English historian Raphael Holinshed and on *The Famous Victories of Henry the Fifth*, a play by an unknown English author. Probably first performed in 1599. First published in 1600.

The play continues the action of *Henry IV*, Part II, and presents an idealized portrait of England's King Henry V. The king decides to press a claim he believes he has to the French throne. He heads an army that lands in France. Inspired by Henry's leadership, the outnumbered English troops defeat the French at the town of Harfleur. The two armies then meet in battle near the village of Agincourt. Against overwhelming odds, the English win a great victory. The triumphant Henry is received at the French court. There he is promised the throne and the hand of Katherine, the French princess with whom he has fallen in love.

The play consists of loosely related episodes unified by the character of the brave but modest king. Shakespeare filled *Henry V* with patriotic passages, especially the king's famous address to his troops at Harfleur. It begins, "Once more unto the breach, dear friends, once more." The speech concludes, "The game's afoot! / Follow your spirit; and upon this charge / Cry 'God for Harry! England and Saint George!'"

Henry claims to hate war in general. Yet he finds himself carried away by the glamour and glory of the French campaign. Although the play occasionally seems to glorify war, Shakespeare set the heroics against a background of political treachery and empty honour. Comic scenes mock the vanity of the royal court. These scenes serve to remind audiences that monarchs and their councils plan wars, but ordinary people must fight and die in them.

Julius Caesar, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1599. First published in 1623.

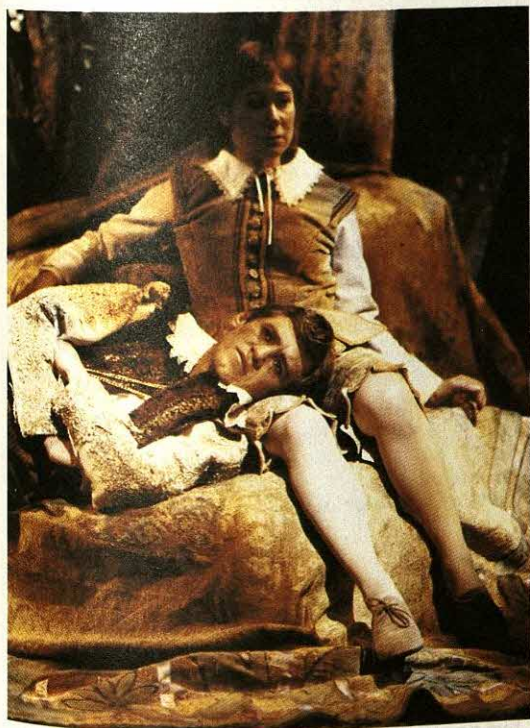
The play takes place in ancient Rome and concerns events before and after the assassination of the Roman ruler Julius Caesar. In spite of its title, the play's central character is Brutus, a Roman general and Caesar's best friend. Brutus reluctantly joins a plot to murder Caesar because he believes Rome's safety requires his death. The plotters attack Caesar in the Roman Senate. He resists until he sees Brutus. Caesar's last words are "Et tu, Brute? [You too, Brutus?] Then fall, Caesar!"

Brutus defends the assassination to a crowd of Romans. But he unwisely allows the clever and eloquent Mark Antony to deliver a funeral speech over Caesar's body. Antony tells the people, "I come to bury Caesar,



Much Ado About Nothing is a romantic comedy that centres on Beatrice and Benedick, *left*, two witty young people who trade insults until they finally realize they love each other. In the production above, the setting has been changed from Italy to the United States in the late 1890's.

not to praise him." He then describes the plotters with heavy sarcasm as "honourable men." At the same time, Antony points out Caesar's virtues and thus gradually turns the crowd into a mob ready to burn and kill in order to avenge Caesar's death. The plotters are forced to flee Rome.



A scene from *Twelfth Night*, in which Shakespeare alternates scenes of romantic action with realistic comedy.

Mark Antony leads an army that defeats the forces of the plotters at the Battle of Philippi. At the end of the battle, Brutus commits suicide. Over his corpse, Antony states, "This was the noblest Roman of them all." Antony says that the other plotters killed Caesar out of envy but only Brutus acted with "honest thought / And common good to all."

Julius Caesar has become a popular play because of its magnificent language and sharp character portraits. For example, Caesar describes the plotter Cassius as having a "lean and hungry look." But the real interest in *Julius Caesar* centres on the character of Brutus. A thoughtful, withdrawn man, he is torn between his affection for Caesar and his sense of duty to the state.

Much Ado About Nothing, a comedy partly based on *Orlando Furioso*, an epic poem by the Italian author Ludovico Ariosto, and on a story in *Novelle*, a collection of tales by the Italian author Matteo Bandello. Probably first performed in 1599. First published in 1600.

This romantic comedy concerns the attempts by the villainous Don John to slander the virtue of Hero, the daughter of the governor of Messina, Italy. After a great deal of intrigue, the play ends happily. However, the real interest in *Much Ado About Nothing* centres on the relationship between Beatrice and Benedick, two witty young people who trade insults throughout most of the play. Their arguments and their final discovery that they love each other provide much of the fun of the play. Adding to the gaiety of the play is the broad humour of the talkative village constable, Dogberry, and his assistant, Verges.

Twelfth Night, a comedy partly based on a story in *Farewell to Military Profession*, a collection of tales by the English author Barnabe Riche. Probably first performed in 1600. First published in 1623.

Viola and Sebastian, who are twins, become separated during a shipwreck. Viola finds herself stranded in the country of Illyria. She disguises herself as Cesario, a

page, and enters the service of Duke Orsino. The duke sends the page to woo the countess Olivia for him. But the countess falls in love with Cesario. Meanwhile, the page only complicates matters further by falling in love with the duke.

The romantic action alternates with scenes of realistic comedy involving the fat knight Sir Toby Belch and his friends. One friend, Sir Andrew Aguecheek, fights Cesario in a comic duel. Maria, the countess Olivia's lady-in-waiting, tricks the countess' steward, Malvolio, into thinking that Olivia loves him. The plot becomes increasingly tangled until Sebastian, Viola's twin brother, appears. Viola then reveals her identity, and the confusion is resolved. Orsino marries Viola, and Sebastian marries Olivia. Only Malvolio is left unhappy.

In *Twelfth Night*, Shakespeare created a perfect blend of sentiment and humour. In addition, he provided Feste, Olivia's clown, with witty comments on the foolish ways of people. Feste's songs contribute both gaiety and sadness to the mood of the play. In one famous song, he reminds the audience that they should enjoy the present because nobody can know what the future will bring:

What is love? 'Tis not hereafter;
Present mirth hath present laughter;
What's to come is still unsure:
In delay there lies no plenty;
Then come kiss me, sweet and twenty!
Youth's a stuff will not endure.

Only Malvolio, who thinks he is more moral than other people, spoils the gentle mood of the play. Sir Toby Belch angrily asks him, "Dost thou think, because thou art virtuous, there shall be no more cakes and ale?" The comedy also contains the famous passage "Some are born great, some achieve greatness, and some have greatness thrust upon 'em."

The premiere of *Twelfth Night* probably took place on the Christian festival known as the Epiphany or Twelfth Night. The festival occurs 12 days after Christmas.

The Merry Wives of Windsor, a comedy possibly based on an unknown source or sources. Probably first performed in 1600. First published in 1602.

This play represents Shakespeare's only attempt to write a realistic comedy. According to a popular though unproven story, Queen Elizabeth requested the play. She so enjoyed the comic character Sir John Falstaff in the *Henry IV* plays that she asked Shakespeare to write a comedy portraying Falstaff in love. The comedy dramatizes Falstaff's efforts to pay court to Mistress Ford and Mistress Page, two honest middle-class housewives in the town of Windsor. Instead of winning their love, Falstaff ends up the victim of a number of comical tricks invented by the women.

Although *The Merry Wives of Windsor* lacks the romantic poetry of most Shakespearean comedies, the play is highly entertaining. The Falstaff in this work has less imagination and wit than the Falstaff in the *Henry IV* plays. But the character remains theatrically effective, even though the audience laughs at him rather than with him, as in the earlier plays.

The third period (1601-1608)

Shakespeare wrote his great tragedies during the third period of his artistic development. Except possibly



The Merry Wives of Windsor dramatizes the efforts of the main character, Sir John Falstaff, left, at wooing two women who have no romantic interest in him.

for *Pericles*, every play of this period shows Shakespeare's awareness of the tragic side of life. Even the period's two comedies—*All's Well That Ends Well* and *Measure for Measure*—are more disturbing than amusing. For this reason, they are often called "problem" comedies or "bitter" comedies. *Troilus and Cressida* is sometimes included in this group of problem plays. Although it is formally a tragedy, it contains much dark and bitter humour. *Pericles* represents Shakespeare's first *romance*—a drama that is generally serious in tone but with a happy ending.

During this period, Shakespeare's language shows remarkable variety and flexibility, moving easily back and forth between verse and prose. His language has become a totally dramatic tool that makes possible the skillful psychological portraits which mark this period.

Hamlet, a tragedy partly based on *Hamlet*, a lost play by an unknown English author, and on a story in *Histoires Tragiques*, a collection of tales by the French author François de Belleforest. Probably first performed in 1601. First published in 1603.

Prince Hamlet of Denmark deeply mourns the recent death of his father. He also resents his mother's remarriage to his uncle, Claudius, who has become king. The ghost of Hamlet's father appears to the prince and tells him he was murdered by Claudius. The ghost demands that Hamlet take revenge on the king.

Hamlet broods about whether he should believe the

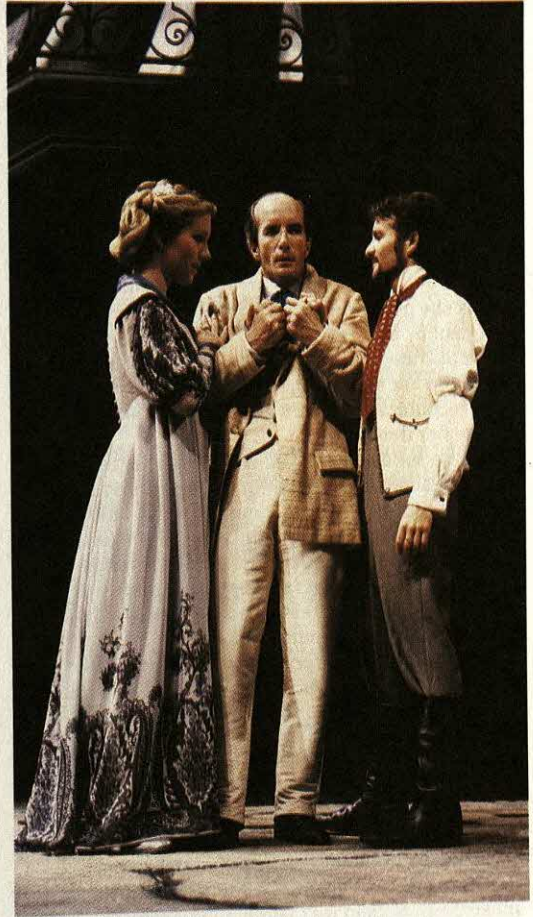
ghost. In his soliloquies, he criticizes himself for not acting against his uncle. He also considers the dangers and rewards of suicide. Hamlet decides to have a band of travelling actors perform "something like the murder of my father" before the king to see if Claudius will show any guilt. The king's violent reaction to the play betrays his guilt. But Hamlet rejects a chance to kill Claudius while he is on his knees in prayer.

Polonius, the king's adviser, decides to eavesdrop on Hamlet while the prince is visiting his mother in her sitting room. He hides behind a curtain, but Hamlet becomes aware that someone is there. Hamlet stabs Polonius through the curtain and kills him.

Claudius exiles Hamlet to England for killing Polonius. He also sends secret orders that the prince be executed after he arrives in England. But Hamlet intercepts the orders and returns to Denmark. He arrives in time to see the burial of Ophelia, the daughter of Polonius. The girl, whom Hamlet had loved, had gone insane following her father's death and drowned herself.

Laertes, Ophelia's brother, blames Hamlet for the deaths of his sister and father. He agrees to a plot suggested by Claudius to kill Hamlet with a poisoned sword in a fencing match. Laertes wounds Hamlet during the duel and, in turn, is wounded himself by the poisoned weapon. While watching the match, Hamlet's mother accidentally drinks from a cup of poisoned wine Claudius had prepared for Hamlet. Although dying from his wound, Hamlet kills Claudius. At the conclusion of the play, Hamlet, his mother, Claudius, and Laertes all lie dead.

Shakespeare handled the complicated plot of *Hamlet* brilliantly. In this play, he also created perhaps his greatest gallery of characters. The role of Hamlet in particular is considered one of the theatre's greatest acting challenges. Shakespeare focused the play on the deep conflict within the thoughtful and idealistic Hamlet as he is torn between the demands of his emotions and the hesi-



The tragedy *Troilus and Cressida* takes place during the Trojan War between ancient Greece and the city of Troy. It dramatizes the love of Troilus, centre, for Cressida.



Detail of an oil painting on canvas (1839) by Eugène Delacroix, the Louvre, Paris (Giraudon/Art Resource)

Hamlet is a tragedy about a sensitive young prince in Denmark who feels he must avenge his father's murder. When Hamlet sees that a gravedigger has unearthed the skull of his father's jester, Yorick, the prince begins to face the reality of death.

tant scepticism of his mind. Hamlet reveals this conflict in several famous and eloquent soliloquies. The best known is his soliloquy on suicide, which begins, "To be, or not to be."

Troilus and Cressida, a tragedy based on several sources, none of which was a chief source. Probably first performed in 1602. First published in 1609.

The story takes place during the Trojan War, fought between ancient Greece and the city of Troy. It dramatizes the love of the Trojan warrior Troilus for the unfaithful Cressida. The couple pledge their love, but Cressida is unexpectedly sent to the Greek camp in exchange for a Trojan prisoner. There she abandons her vow to Troilus and takes the Greek warrior Diomedes as her lover. The play ends with the death of Troilus' brother, the great Trojan hero Hector.

In spite of its heroic setting, *Troilus and Cressida* is neither noble nor stirring. Except possibly for Hector, all the characters act less than heroically. In both outlook and style, the play has more in common with the problem comedies that Shakespeare wrote than with the great tragedies.

All's Well That Ends Well, a comedy partly based on a story in *The Palace of Pleasure*, a collection of tales by various European authors, as translated by William Painter, an Englishman. Probably first performed in 1603. First published in 1623.

This play takes place in France and Italy. Helena, the beautiful orphaned daughter of a physician, loves Bertram, a nobleman. In Paris, Helena cures the French king of an illness and wins Bertram as her husband in reward. But Bertram considers Helena beneath him socially and deserts her immediately after the wedding. He tells her in a letter that she can never call him husband unless she gets a ring from his finger and becomes pregnant by him. Helena fulfils both conditions. One night, unknown to Bertram, she takes the place of a girl for whom her husband has a foolish passion. Bertram finally recognizes his wife's good qualities and promises to love her dearly.

On the surface, *All's Well That Ends Well* resembles other Elizabethan comedies of romantic intrigue. But unlike Shakespeare's earlier comedies, it has little gaiety and romance. Bertram's conduct makes him an unattractive hero. Many critics also dislike Helena for throwing herself at him. The play's interest lies primarily in Shakespeare's efforts to express through comedy his troubled view of humanity's imperfections.

Measure for Measure, a comedy partly based on *Promos and Cassandra*, a play by the English author George Whetstone. Probably first performed in 1604. First published in 1623.

Vincentio, Duke of Vienna, turns over the affairs of the city to Angelo, his stern deputy, and Escalus, a wise old nobleman. The duke hopes the two men will introduce needed moral reforms in Vienna. In one of his first acts, Angelo sentences Claudio to death for making Juliet, his fiancée, pregnant. Claudio's sister, Isabella, pleads with Angelo for Claudio's life. Overcome by her

beauty, Angelo agrees to save Claudio if she will allow him to make love to her. Isabella refuses, preferring to let her brother die rather than yield her honour. After much intrigue and plotting, Claudio is saved, Isabella keeps her virtue, and Angelo's wicked deeds are exposed.

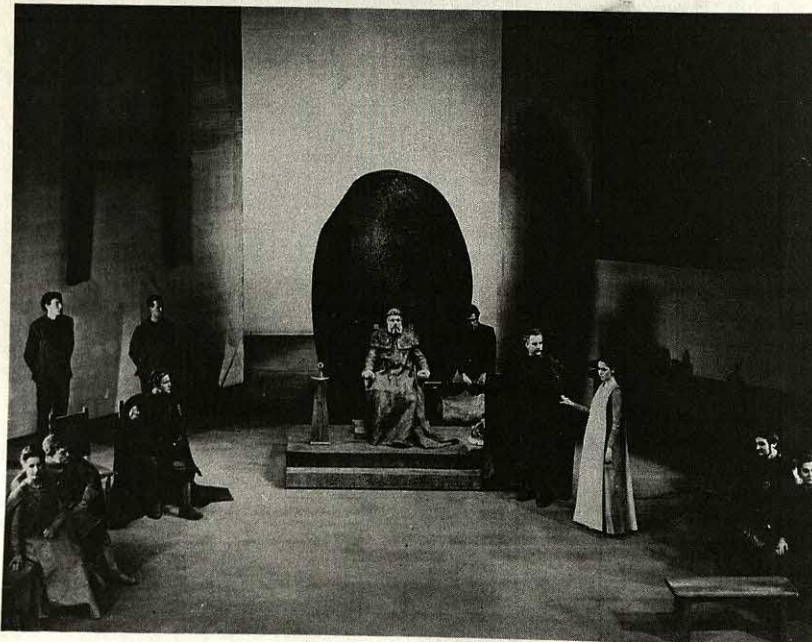
Many critics have objected to the happy ending of *Measure for Measure*. They consider it false to the spirit of the play. The first part of the play is serious, almost tragic. The latter part becomes a typical romantic intrigue. This lack of artistic unity creates problems. The first part of the play, for example, seriously raises questions about the nature of justice. But these questions seem to be answered too lightly at the play's end.

In spite of its flaws, *Measure for Measure* has many excellent features. Shakespeare drew the characters of Angelo and Isabella with keen understanding. He also included much broad comedy that is highly effective. In addition, his dramatic poetry at times equals that of the best in his tragedies.

Othello, a tragedy partly based on a story in *Hecatomithi*, a collection of tales by the Italian author Cinthio. Probably first performed in 1604. First published in 1622.

Othello, a noble black Moor (North African), has spent his life as a soldier and become a general in the army of Venice, Italy. He marries Desdemona, a beautiful Venetian girl much younger than himself. Almost immediately after the marriage, Othello is ordered to Cyprus, where Desdemona joins him. Othello's villainous aide, Iago, hates the Moor. Iago decides to destroy Othello by persuading him that Desdemona has made love with Cassio, Othello's lieutenant.

Iago quickly convinces Othello that Desdemona has been unfaithful. He achieves his goal by taking advantage of Othello's insecurity over his colour, age, and lack of sophistication. Constantly tormented by Iago, Othello



In *King Lear*, Shakespeare created the brilliant characterizations that mark his dramas at their best. The aged king, centre, realizes his mistakes but too late to prevent the tragedy that results.

murders Desdemona. After the Moor learns he has been tricked, he stabs himself and dies, describing himself as "one that loved not wisely, but too well."

This play is Shakespeare's most straightforward tragedy. The action moves rapidly, and the language is simple and direct, like the main character. *Othello* and *Romeo and Juliet* differ from Shakespeare's other tragedies in that neither deals with public affairs and royalty. Instead, *Othello* is a tragedy of personal tensions. It combines the emotions of love and hatred, and of jealousy and impatience.

King Lear, a tragedy partly based on the *Chronicles* by the English historian Raphael Holinshed; *The True Chronicle History of King Leir*, a play by an unknown English author; and *Arcadia*, a romance in prose and verse by the English author Sir Philip Sidney. Probably first performed in 1605. First published in 1608.

The main plot concerns Lear, an aged king of ancient Britain. He prepares to divide his kingdom among his three daughters—Regan, Goneril, and Cordelia. Lear becomes angry when Cordelia, his youngest daughter, refuses to flatter him to gain her portion of the kingdom. Lear rashly disinherits her. He also exiles his trusted adviser, Kent, for supporting Cordelia.

Regan and Goneril soon show their ingratitude. They deprive Lear of his servants and finally force him to spend a night outdoors during a storm accompanied only by his jester, called the Fool. Lear's mind begins to snap under the strain. But as he approaches madness, he finally sees his errors and selfishness. Cordelia, who had been living in France, returns to Britain and finds the king insane. Lear recovers his sanity and recognizes her. Armies raised by the wicked sisters capture Lear and Cordelia, who is put to death. Meanwhile, Goneril has poisoned Regan in a bitter quarrel over a man they both love and then killed herself. Order is finally restored in the kingdom. But Lear dies of a broken heart as he kneels over the body of Cordelia.

Shakespeare skilfully wove a subplot into the main story of Lear and his daughters. Gloucester, a nobleman in Lear's court, makes the mistake of banishing his faithful son, Edgar, and trusting his wicked son, Edmund. Edmund soon betrays his father, who is blinded by Regan's husband. Edgar discovers his blind father and comforts him. Gloucester realizes his errors and especially his lack of concern for people less fortunate than himself. He then dies.

In *King Lear*, Shakespeare created the brilliant characterizations that mark his dramas at their best. The characters realize their mistakes, which reflects Shakespeare's basic optimism. But they do so too late to prevent their destruction and that of the people around them. This fact is at the heart of Shakespeare's tragic view of humanity.

Macbeth, a tragedy partly based on the *Chronicles* by the English historian Raphael Holinshed. Probably first performed in 1606. First published in 1623.

This play is set in Scotland. Returning from battle with his companion Banquo, the nobleman Macbeth meets some witches. They predict that Macbeth will first become *thane* (baron) of Cawdor and then king of Scotland. Macbeth privately has had ambitions of being king. After the first part of the witches' prophecy comes true, he begins to think the second part may also come true.

Encouraged by Lady Macbeth, his wife, Macbeth murders King Duncan, a guest in his castle. Macbeth then seizes the throne of Scotland.

But Macbeth has no peace. Duncan's sons have escaped to England, where they seek support against Macbeth. In addition, the witches had also predicted that Banquo's descendants would be kings of Scotland. Macbeth therefore orders the murder of Banquo and his son, Fleance. Macbeth's men kill Banquo, but Fleance escapes. Macbeth is now hardened to killing. He orders the murder of the wife and children of his enemy Macduff, who had fled to England after Duncan's murder. Macduff then gathers an army to overthrow Macbeth. By this time, Lady Macbeth, burdened with guilt over the murders, has become a sleepwalker. She finally dies. At the end of the play, Macduff kills Macbeth in battle. Duncan's son Malcolm is then proclaimed king of Scotland.

In *Macbeth*, Shakespeare wrote a tragedy of a man's conscience. During the course of the play, Macbeth changes from a person of strong but imperfect moral sense to a man who will stop at nothing to get and keep what he wants. By the play's end, Macbeth has lost all emotion. He cannot even react to his wife's death, except to conclude that life is only "a tale / Told by an idiot, full of sound and fury, / Signifying nothing." On the other hand, Lady Macbeth encourages murder in the beginning. But her conscience grows as her husband's lessens. In addition to its psychological insights, *Macbeth* has many passages of great poetry. The play is also noted for its bitter humour, which reinforces the tragic action.

Timon of Athens, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1607. First published in 1623.

Timon is a nobleman in ancient Athens. Surrounded by flatterers, he spends his money extravagantly. But after he becomes penniless, his friends desert him. Their ingratitude turns Timon into a bitter person who hates humanity. Timon leaves Athens and goes to live in a cave near the sea, where he finds buried treasure. But his new-found wealth brings him no happiness. He dies, still a bitter man, in the cave.

Although *Timon of Athens* has flaws, it also has passages of great eloquence. Several such passages occur when Timon pours out his scorn for humanity. Throughout the play, Shakespeare portrays people at their worst, with few of the honourable qualities that lighten the gloom in his great tragedies.

Pericles, a romance partly based on a story in *Confessio Amantis*, a collection of European tales retold by the English poet John Gower. Probably first performed in 1607. First published in 1609.

The action in *Pericles* covers many years and ranges over much of the ancient Mediterranean world. The plot deals with the adventures of Prince Pericles of Tyre. It tells of his marriage, the apparent loss of his wife and daughter, and his rediscovery of them. The play is notable for the characters of the virtuous Pericles and his equally virtuous daughter, Marina. The most moving scene in *Pericles* comes near the end of the play, when Pericles and Marina meet and recognize each other after years of separation.

The play consists of many loosely related episodes and is uneven in quality. Scholars disagree over how much of *Pericles* Shakespeare actually wrote. But the majority believe he wrote most or all of it.

Antony and Cleopatra, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1607. First published in 1623.

Mark Antony, together with Octavius and Lepidus, rules the Roman Empire. Antony lives in Roman-conquered Egypt, where he has taken the Egyptian queen, Cleopatra, as his mistress. Political problems in Rome and the death of his wife force Antony to leave his life of pleasure and return home. Back in Rome, he marries Octavius' sister Octavia for political reasons. But Antony soon returns to "his Egyptian dish." Octavius then prepares for war against him.

Antony decides unwisely to fight Octavius at sea. During the battle, Cleopatra's fleet deserts him, and Antony flees with the queen. After Cleopatra's ships desert him in a second battle, Antony finally realizes that he has lost everything. Cleopatra deceives him into thinking that she is dead, and Antony stabs himself. But before he dies, he learns that Cleopatra is still alive. Antony then returns to her and dies in her arms. Cleopatra dresses

herself in her royal robes, presses a poisonous snake to her breast, and dies of its bite.

The dazzling poetry of *Antony and Cleopatra* is one of the tragedy's most notable features. Early in the play, Enobarbus, one of Antony's officers, gives a famous description of Cleopatra that begins, "The barge she sat in, like a burnished throne, / Burned on the water." Cleopatra is Shakespeare's finest female portrayal. At one moment she is playful, then sulking, and then filled with deadly anger. As Enobarbus says:

Age cannot wither her, nor custom stale
Her infinite variety. Other women cloy
The appetites they feed, but she makes hungry
Where most she satisfies. . . .

Shakespeare's dramatic use of poetry reveals Antony and Cleopatra from various points of view. On one level, they are merely two people exhausted by a life of excessive pleasure and luxury. On another level, they are tragic characters willing to risk kingdoms for their love. Shakespeare laughs at them for their foolishness, sympathizes with them for their suffering, and admires them for their moments of personal nobility.

Coriolanus, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1608. First published in 1623.

Caius Marcius, a general in ancient Rome, wins the name Coriolanus after he captures Corioli, the capital city of a people known as the Volscians. Coriolanus returns to Rome in triumph and is nominated for the important office of consul. But he cannot hide his scorn for the common people, whose support he needs to become consul. Coriolanus' superior attitude leads to his exile. He joins forces with his old enemy, the Volscian general Tullus Aufidius, and heads an army against Rome. Coriolanus' mother, wife, and young son meet him outside the city and beg him to spare it. Moved by their pleas, Coriolanus withdraws his troops. Aufidius denounces him as a traitor and has him murdered.

In *Coriolanus*, Shakespeare raised issues that remain particularly important today. The tragedy questions the values of personal popularity and political success. It also debates the conflicting interests of public and private life.

The fourth period (1609-1613)

During his final period, Shakespeare wrote four plays—three comedies and a history. Most scholars label these three comedies and *Pericles* as his romances. Shakespeare probably wrote the history, *Henry VIII*, with John Fletcher.

The three romances are beautifully constructed, and their poetry ranks among Shakespeare's finest writing. But unlike his masterpieces of the third period, the romances seem detached from reality. Scholars disagree on the reason for this change in Shakespeare's works. Some claim he was calmly looking back on his life and philosophically summing up his career. Other scholars believe that Shakespeare wrote the romances to suit the changing tastes of his audience. They feel that these dramas reflect the growing popularity of plays that mixed comic and serious qualities. The romances probably represent both a change in Shakespeare's attitude to-



Antony and Cleopatra reveals Shakespeare's brilliant use of poetry at its best. Cleopatra, left centre, commits suicide after her deceit of Antony led to his suicide.

ward life and an attempt to follow theatrical fashions.

Cymbeline, a romance partly based on several sources, none of which was a chief source. Probably first performed in 1609. First published in 1623.

Cymbeline, king of Britain, angrily exiles the poor but honourable Posthumous after the young man marries Imogen, the king's daughter. The treacherous Iachimo bets Posthumous that Imogen is not virtuous. Iachimo then tries to make love to her. He fails but tricks Posthumous into believing that Imogen let him do so. Posthumous orders his wife killed, but she escapes disguised as a court page. After many adventures, Imogen and her husband are happily reunited. Iachimo, filled with regret, confesses his wickedness.

The characters in *Cymbeline* are expertly drawn. Imogen in particular is one of Shakespeare's most appealing heroines. The play also has a lively, melodramatic plot. The plot moves close to tragedy but never quite touches the tragic level.

The Winter's Tale, a romance partly based on *Pandosto*, a prose romance by the English author Robert Greene. Probably first performed in 1610. First published in 1623.

Leontes, king of Sicilia, becomes uncontrollably jealous of his faithful wife, Hermione. He has her imprisoned and orders that their newborn daughter, Perdita, be abandoned in some isolated place. Leontes finally realizes that he has no cause for jealousy. But his conduct has cost him his friends and family, including his wife, who has fallen into a deathlike faint.

Meanwhile, Perdita has been saved by an old shepherd. She grows into a lovely young girl and wins the love of Florizel, prince of Bohemia. But Florizel's father angrily disapproves of their romance, and the couple flee to Leontes' court for protection. There, Leontes discovers that Perdita is his daughter. The king's happiness is complete when he is also reunited with his wife, whom he thought was dead. She had actually been living alone while hoping for the return of Perdita.

Like *Cymbeline*, *The Winter's Tale* concerns exile, women suffering from male jealousy, and the reuniting of loved ones. Also like the earlier play, *The Winter's Tale* takes a potentially tragic situation and uses it to stress rebuilding rather than destruction. The characters in this drama, made wiser by their sad experiences, happily face the future.

The Tempest, a romance partly based on several sources, none of which was a chief source. Probably first performed in 1611. First published in 1623.

Prospero, the wrongfully exiled Duke of Milan, Italy, lives on an enchanted island with his beautiful daughter, Miranda. The mischievous spirit Ariel and the monster Caliban serve Prospero, who is a skilled magician. Using magic, Prospero creates a *tempest* (storm) that causes a ship carrying his enemies to be wrecked on the island. The ship also carries the young prince Ferdinand. Miranda loves him at first sight and cries out, "O brave new world that hath such creatures in it." With his magic, Prospero brings Miranda and Ferdinand together and upsets plots laid against him by his shipwrecked enemies. Prospero appears before his enemies and forgives them. He decides to give up his magic and return to



The Tempest was Shakespeare's last great comedy. The play takes place on an enchanted island ruled by Prospero, a magician, *centre*. Prospero lives there with his daughter, Miranda, *right*, and his unwilling slave, the monster Caliban, *left*.

Italy, where Ferdinand and Miranda can be married.

Like *Cymbeline* and *The Winter's Tale*, *The Tempest* tells a story in which old injuries are forgiven and the characters begin a new and happier life. In *The Tempest*, Shakespeare blended spectacle, song, and dance with a romantic love story, beautiful poetry, and broad comedy. The result of this blending is a brilliant dramatic fantasy. In one of Shakespeare's most famous speeches, Prospero tells the audience:

Our revels now are ended. These our actors,
As I foretold you, were all spirits and
Are melted into air, into thin air;
And, like the baseless fabric of this vision,
The cloud-capped towers, the gorgeous palaces,
The solemn temples, the great globe itself,
Yea all which it inherit, shall dissolve,
And, like this insubstantial pageant faded,
Leave not a rack behind.

Many scholars have taken these lines to be Shakespeare's farewell to his profession. But no one knows if he intended the speech to be autobiographical.

Henry VIII, a history partly based on the *Chronicles* by the English historian Raphael Holinshed and on *The Book of Martyrs*, a religious work by the English author John Foxe. Probably first performed in 1613. First published in 1623.

The play dramatizes the events that led to England's break with the Roman Catholic Church. It deals with King Henry VIII's divorce of Catherine of Aragon and his marriage to Anne Boleyn. The play also covers the fall of Cardinal Wolsey as the king's adviser and the rise of Archbishop Cranmer as Wolsey's replacement. *Henry VIII* is a loosely constructed drama and better known for its pageantry than for its characterization. Although the play does have passages of splendid verse, the work as a whole does not show Shakespeare at the height of his creative powers.

Shakespeare wrote two long poems, *Venus and Adonis* and *The Rape of Lucrece*. Both are narrative poems—that is, they tell a story. Shakespeare also composed a sequence of 154 sonnets and a short poem called "The Phoenix and the Turtle."

The narrative poems

Venus and Adonis (1593) is partly based on the *Metamorphoses*, a collection of tales in verse by the ancient Roman poet Ovid. The poem tells how Venus, the goddess of love, tries to win the love of the handsome young mortal Adonis. He resists her and is finally killed by a wild boar while hunting.

Shakespeare wrote *Venus and Adonis* in six-line stanzas. Most of the lines have five accented syllables. The lines of *Venus and Adonis* rhyme *ababcc*, which means the first and third lines rhyme, as do the second and fourth, and the fifth and sixth.

The poem is witty and filled with sexual references. But the work is most notable for its vivid settings and its formal and elaborate speeches. *Venus and Adonis* represents Shakespeare's successful attempt to write the kind of love poetry that was popular among literary members of the royal court.

The Rape of Lucrece (1594) is also partly based on the works of Ovid, as well as on writings by other authors. The poem tells of Lucrece, the virtuous wife of a Roman nobleman. She is sexually attacked by the lustful general Tarquin. After the rape, Lucrece demands that her husband and his friends swear to revenge her ruined honour. She then kills herself.

Shakespeare wrote *The Rape of Lucrece* in seven-line stanzas, each line having five accents. The lines rhyme *ababcc*. The poem is more serious in tone than *Venus and Adonis*. The work has little action and, like the earlier poem, depends greatly on long flowery speeches for its effect.

The sonnets

In the late 1500's, it was fashionable for English gentlemen authors to write sequences of sonnets. Some sonnet sequences followed a narrative pattern that was autobiographical in varying degrees. For this reason, scholars have tried to learn about Shakespeare's life from his sonnets. But they have reached no general agreement on autobiographical information that the poems might contain.

Scholars generally do agree, however, that Shakespeare addressed the first 126 sonnets to a young nobleman and that the next 26 concentrate on a woman. But they have not been able to identify either person. They have long debated over the nature of Shakespeare's relationship with the young man and have come to no general conclusion. Many scholars believe that Shakespeare had a passionate but somewhat reluctant love affair with the woman. Because the poems describe the woman as a brunette, she has become known as the "dark lady" of the sonnets. Sonnets 153 and 154 seem unrelated to the others, and some scholars doubt that Shakespeare wrote them.

Composition and publication. Shakespeare probably wrote the sonnets over a period of several years,

though their dates are not clear. He wrote the poems in three units of four lines each with a concluding couplet (two-line unit). Shakespeare's sonnets rhyme *abab cdcd efef gg*.

Two of the sonnets originally appeared in a book of poetry called *The Passionate Pilgrim* (1599). Thomas Thorpe published the sonnets as a collection in 1609. Thorpe dedicated the book to Mr. W. H., whom he called "the only begetter of these ensuing sonnets." Scholars do not know who Mr. W. H. was or even if he inspired the poems or merely collected them for the publisher. The individual poems have no titles. Scholars refer to them either by their first line or by the number Thorpe assigned to them.

Themes. In the sonnets addressed to his aristocratic friend, Shakespeare treated a variety of subjects. "Shall I compare thee to a summer's day?" (sonnet 18) praises physical beauty. "When, in disgrace with Fortune and men's eyes" (sonnet 29) describes the power of friendship to cheer the poet. Some of the sonnets are particularly notable for their wit, as in "That time of year thou mayst in me behold" (sonnet 73).

In several of the first 126 sonnets, Shakespeare referred to another poet he considered a rival for his young friend's affection and support. Scholars have called this person the "rival poet." They do not know who he was or if he even existed.

The sonnets' most common themes concern the destructive effects of time, the quickness of physical decay, and the loss of beauty, vigour, and love. Although the poems celebrate life, it is always with a keen awareness of death. This awareness of death is perhaps best expressed in "Poor soul, the centre of my sinful earth" (sonnet 146).

A distrust of love and human nature runs through the "dark lady" sonnets. Sonnet 138, which appears below, reflects this attitude. In addition, the poem is representative of the entire sequence in two ways. The sonnet tells of the poet's concern over the passing of time; and it shows his strong emotion controlled by his highly intellectual wit.

When my love swears that she is made of truth
I do believe her, though I know she lies,
That she might think me some untutored youth,
Unlearned in the world's false subtleties.
Thus vainly thinking that she thinks me young,
Although she knows my days are past the best,
Simply I credit her false-speaking tongue:
On both sides thus is simple truth suppressed.
But wherefore says she not she is unjust?
And wherefore say not I that I am old?
O, love's best habit is in seeming trust,
And age in love loves not to have years told.
Therefore I lie with her and she with me,
And in our faults by lies we flattered be.

"The Phoenix and the Turtle"

This 67-line poem appeared in 1601 in a collection called *Love's Martyr*. It praises ideal love, using as symbols two birds, the phoenix and the turtledove. The poem has philosophical and symbolic qualities that have led to various biographical, political, and religious interpretations by critics.

Shakespeare and other Elizabethan writers looked upon the English language as alive and changing. They did not consider it fixed for all time in a set of correct and unbreakable rules. Shakespeare experimented freely with sentence structure and vocabulary to create special effects. He also used various literary devices to present information and ideas in a dramatic and appealing way. But Shakespeare's style is perhaps best known for its brilliant use of language to create vivid pictures in the mind.

Shakespeare's style has helped shape the language of all English-speaking countries. This influence has chiefly been felt directly through his writings. But it has also been felt through the interest his work has aroused in the literature of the Elizabethan period in general. Many later writers in English have accepted the Elizabethan style as their model. As a result, much English and American literature reflects the highly individualized enthusiasm of most Elizabethan writing.

Vocabulary. Shakespeare changed words, invented words, and borrowed words from other languages. He even used nouns as verbs for dramatic effect. In *Measure for Measure*, for example, a character remarks that Angelo "dukes it well," referring to the forceful way in which Angelo handles the duties of the absent Duke of Vienna. Shakespeare also used verbs in both their modern form—for example, *has*—and in their older form—*hath*. In the same way, Shakespeare used both modern pronouns, such as *you*, and older pronouns, such as *thee* or *thou*.

Some of Shakespeare's words may be unfamiliar or confusing to modern readers and theatregoers. His vocabulary basically resembles modern English, but he employed many words that are no longer used. Readers and theatregoers may also be puzzled by familiar words that had additional or different meanings in Shakespeare's time. In *Othello*, for example, Iago raises a "shrewd doubt" about Desdemona's faithfulness. In this case, "shrewd" means "serious" or "grave," not its modern meaning, "clever." Most editions of Shakespeare's plays include notes that define such words.

Rhetoric. Shakespeare and other Elizabethan writers enjoyed using *rhetoric*—special literary devices that present a fact or idea in a dramatic and interesting manner. Indeed, authors were often more concerned with how something was said than with what was actually said.

Shakespeare used many kinds of rhetorical devices that writers still use. One familiar kind is *alliteration*, in which the same sound is repeated in a line or group of lines of verse. When Juliet tells Romeo that "parting is such sweet sorrow," the *s* sounds of the last three words provide alliteration. Shakespeare also frequently used a rhetorical device called *repetition*. Hamlet's cry against his stepfather "O villain, villain, smiling, damned villain!" shows effective dramatic use of repetition.

Shakespeare's rhetoric became more skilful as he matured as a playwright. In his early play *Richard III*, for example, much of the repetition is artificial and awkward. But in his later plays, Shakespeare used repetition naturally and effectively. An example can be shown from *Othello*. The Moor, carrying a candle, looks at his sleep-

ing wife and prepares to murder her. He utters the simple and moving sentence "Put out the light, and then put out the light." He then proceeds to debate the finality of death before he smothers his wife. This rhetorical device is called *antanaclasis*, which means the repetition of a certain word or phrase but with a deliberate shift in its meaning.

Like other poets, Shakespeare often used *metaphor*—a figure of speech in which two different things are compared. In *As You Like It*, for example, Jaques begins a famous soliloquy with a metaphor:

All the world's a stage,
And all the men and women merely players.
They have their exits and their entrances,
And one man in his time plays many parts,
His acts being seven ages.

Shakespeare enjoyed using *puns* (humorous plays on words). In *Cymbeline*, he wrote, "Golden lads and girls all must, / As chimney-sweepers, come to dust." The lines express the serious thought that even beautiful young people must grow old and die, but the pun adds a light touch. In *Henry V*, Pistol, an English soldier fighting in France, says, "To England will I steal, and there I'll steal."

Imagery. The richness and precision of Shakespeare's imagery give his writing its unique style. A famous example of his brilliant imagery comes from *Macbeth*. Horrified by his murder of King Duncan, Macbeth looks at his bloodstained hands and says:

What hands are here? Ha! They pluck out mine eyes!
Will all great Neptune's ocean wash this blood
Clean from my hand? No. This my hand will rather
The multitudinous seas incarnadine,
Making the green one red.

The image of Duncan's blood turning all the oceans *incarnadine* (blood-red) reveals the terrifying sorrow Macbeth feels over committing the murder.

Another vivid example of Shakespeare's imagery appears in *Richard II*. Richard warns Bolingbroke that his rebellion against the king will bring the horrors of civil war to England:

He is come to open
The purple testament of bleeding war.
But ere the crown he looks for live in peace,
Ten thousand bloody crowns of mothers' sons
Shall ill become the flower of England's face,
Change the complexion of her maid-pale peace
To scarlet indignation, and bedew
Her pastures' grass with faithful English blood.

Verse form. Shakespeare reinforced his imagery with the rhythm of his verse. He composed his plays largely in blank verse—that is, in lines of unrhymed iambic pentameter. In such a pattern, each line is divided into five units called *feet*, with the accent falling on every second syllable. Of all English metrical patterns, blank verse—particularly when occasionally varied—comes closest to the rhythms of everyday speech. In his earliest plays, much of Shakespeare's blank verse was stiff and artificial. But it soon developed into a completely flexible dramatic instrument. Through his verse, Shakespeare could create a feeling of speed and excitement or a sense of calm dignity.

No manuscripts of Shakespeare's plays exist. As a result, modern editions of the plays must be based on early published texts. There are two kinds of these texts, *quartos* and *folios*. A quarto is a small volume containing one Shakespeare play. A folio is a large volume of his collected plays. Nineteen of Shakespeare's plays first appeared in quarto form. For his remaining 18 plays, a folio is the only source.

The publishing history of Shakespeare's plays has been a story of constant attempts by editors to correct errors in the quartos and folios. Editors have also tried to explain difficult words and phrases in the light of new historical information.

Quartos have been classified as *good quartos* and *bad*, or *pirated*, *quartos*. The good quartos were probably printed either from Shakespeare's own manuscripts or from reasonably accurate copies of them. Generally, the good quartos provide a clear and readable text, though Elizabethan printing was careless by modern standards. The bad quartos are shortened versions of the plays. They differ sharply from folio and good quarto texts. The bad quartos have so many errors that in places they are almost meaningless. These quartos were published without permission from Shakespeare's company. Scholars generally agree that the texts were reconstructed from memory by one or more actors who had appeared in the plays.

Folios. The first edition of Shakespeare's collected plays is called the *First Folio*. Isaac Jaggard, a printer, and Edward Blount, a bookseller, published the volume in 1623, seven years after Shakespeare died. The book contains all Shakespeare's accepted plays except *Pericles*. John Heminge and Henry Condell, former members of Shakespeare's company, assembled the plays. In the introduction, they wrote that the plays were "absolute in their numbers, as he [Shakespeare] conceived them." Although the First Folio does not quite live up to this statement, it remains an outstanding publishing achievement for its time.

Heminge and Condell obtained the texts of the plays from various sources, including quartos and playhouse *promptbooks*. A promptbook was a copy of the script with detailed directions for performing the play. The First Folio was followed by the Second Folio (1632), the Third Folio (1663-1664), and the Fourth Folio (1685). The final three folios show attempts at editorial corrections, but they are not considered dependable texts.

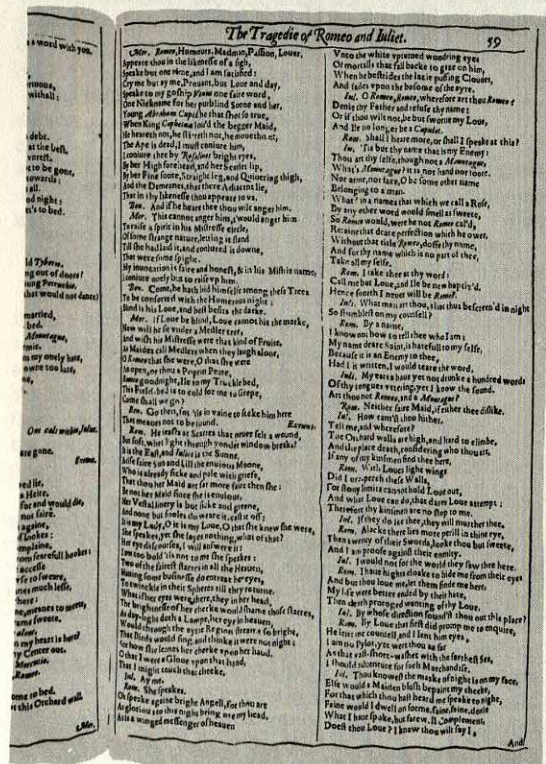
Editions of the 1700's and 1800's. During the 1700's, several English editors worked to produce better texts of Shakespeare's plays. Nicholas Rowe made the first important attempt with a multivolume edition published in 1709. Other notable editors of the 1700's, with the year in which their edition appeared, included Alexander Pope (1725), Lewis Theobald (1733), Samuel Johnson (1765), Edward Capell (1768), and Edmund Malone (1790). Theobald's edition is particularly important for its many corrections that try to restore the text to its original meaning. Johnson's edition is significant for its scholarly comments on the plays themselves.

The first *variorum* editions of the plays appeared during the 1800's. Variorum editions include notes by previous editors as well as alternate versions of disputed passages. The most elaborate edition is the *New Variorum* edited by H. H. Furness and others. The first volume was published in 1871. The project is still in progress.

In the 1800's, the most important edition of the plays probably was the nine-volume *Cambridge Shakespeare* (1863-1866) edited by W. G. Clark, J. Glover, and W. Aldis Wright. In 1864, the edition was published in a single volume. Known as *The Globe Shakespeare*, it became the standard work for scholarly reference.

Modern editions. Shakespearean editions of the 1900's show an increased awareness of the social and intellectual background against which Shakespeare worked. Modern editors also have been able to interpret difficult passages and resolve textual problems with more confidence than earlier editors could. This confidence has resulted from new knowledge gained about printing and publishing during the Elizabethan Age.

Modern multivolume editions include the *New Arden Shakespeare* (1951-1982) and the *New Penguin Shakespeare* (1967-1988). In the early 1980's, Cambridge University and Oxford University began issuing new editions that will reflect the latest computer-assisted textual scholarship. Several single-volume editions also provide dependable texts and helpful comments. They include *The Complete Pelican Shakespeare* (1969), *The Riverside Shakespeare* (1974), and *The Complete Works of Shakespeare* (1980), edited by David Bevington.



The First Folio was the earliest edition of Shakespeare's collected plays. The book was published in London in 1623. A page from the tragedy *Romeo and Juliet* is reproduced above.

Shakespearean criticism—that is, serious analysis of Shakespeare and his works—did not begin until the late 1600's. During Shakespeare's lifetime, Robert Greene apparently attacked Shakespeare for thinking he could write as well as university-educated playwrights. Francis Meres considered Shakespeare the best English stage dramatist for comedy and tragedy. The First Folio, which appeared in 1623 after Shakespeare's death, contained a number of poems praising Shakespeare. The poems included a famous tribute by the playwright Ben Jonson. Jonson said of Shakespeare, "He was not of an age, but for all time!" But all these comments cannot be considered formal criticism.

Neoclassical criticism. Scholars have traditionally called the period of English literature from 1660 to 1798 the neoclassical period. During this period, drama criticism was heavily influenced by the theories of the ancient Greek philosopher Aristotle. Neoclassical critics believed that Aristotle had established certain rules for writing drama. Many of these critics were bothered by Shakespeare's failure to follow these rules. For example, Shakespeare often broke the neoclassical rule against mixing comedy with tragedy. Most of the critics concluded, however, that Shakespeare was unaware of Aristotle's theories and so could be excused for ignoring them.

A landmark of neoclassical criticism of Shakespeare appeared in John Dryden's *An Essay of Dramatic Poesy* (1668). This work is usually considered the first serious criticism of the dramatist. In the essay, Dryden compared Shakespeare with Ben Jonson. Dryden wrote that he admired Jonson for being "the more correct poet." However, he loved Shakespeare, who "needed not the spectacles of books to read Nature" but "looked inwards, and found her there."

The most sensible neoclassical criticism came from the writer Samuel Johnson. He praised Shakespeare for holding up a "faithful mirror of manners and of life." He also recognized the universal appeal of Shakespeare's plays. At the same time, Johnson criticized what he considered to be Shakespeare's weaknesses. For example, Johnson objected to many comic sexual passages, which he considered vulgar.

In his influential *An Essay on the Dramatic Character of Sir John Falstaff* (1777), Maurice Morgann tried to show that Falstaff was not really a coward, as other critics claimed. Morgann analysed the comic figure in great detail, as if Falstaff were a real person. Many later critics also came to regard Shakespeare's major characters as actual people independent of the plays.

Romantic criticism. A movement called romanticism began to influence English literature significantly about 1798. Its influence lasted through most of the 1800's. The romantic critics tended to glorify Shakespeare almost as a god who could do no wrong. Some romantic critics believed that Shakespeare's plays should properly be studied as nondramatic literature and not simply as works for the stage.

In spite of their one-sided view of Shakespeare's genius, the romantics produced many outstanding works of criticism. These works included Charles Lamb's *On the Tragedies of Shakespeare* (1811) and William Hazlitt's

Characters of Shakespeare's Plays (1817). The lectures and essays of Samuel Taylor Coleridge also rank as landmarks of Shakespearean criticism.

Romantic criticism reached a climax with two books. The first was Edward Dowden's *Shakspeare: A Critical Study of His Mind and Art* (1875). The book attempts to relate the moral problems posed in the plays to Shakespeare's own experience with those problems. The second influential book was A. C. Bradley's *Shakespearean Tragedy* (1904). Bradley examined *Hamlet*, *Othello*, *King Lear*, and *Macbeth* and tried to show that the major characters behave in a psychologically valid way.

Modern criticism. Critics in the 1900's have profited greatly from modern scholarship in all areas of Shakespeare's life, times, and writings. The following discussion deals with some of the major contributions that British and American scholars have made to modern Shakespearean criticism.

Many scholars have concentrated on the study of Shakespeare's early texts to bring critics closer to what the playwright actually wrote. The leading textual scholars of the early 1900's include W. W. Greg, R. B. McKerrow, A. W. Pollard, and J. Dover Wilson.

Modern scholars have also explored the conditions under which Shakespeare's plays were first produced. They have done research on the theatre buildings, the actors, and the audiences. Joseph Quincy Adams' *Shakespearean Playhouses* (1917) and E. K. Chambers' four-volume *The Elizabethan Stage* (1923) provided the basis for many later studies. The most important of these studies include Alfred Harbage's *Shakespeare's Audience* (1941) and John Cranford Adams' *The Globe Playhouse* (1942). However, many of Adams' conclusions have been challenged by later scholars.

The scholarship of the 1900's has resulted in a variety of critical approaches to Shakespeare's plays. E. E. Stoll studied the plays in terms of Elizabethan theatrical traditions. Lily Bess Campbell, Hardin Craig, Theodore Spencer, and E. M. W. Tillyard analysed the plays in the light of Elizabethan ideas on history, philosophy, and psychology. Harley Granville-Barker wrote a series of essays called *Prefaces to Shakespeare* (1927-1947). In these essays, Granville-Barker examined the plays as works for the stage and rejected the romantic belief that the plays should be studied rather than performed.

In the 1930's, critics began to show strong interest in Shakespeare's imagery. In *Shakespeare's Imagery and What It Tells Us* (1935), Caroline Spurgeon attempted to discover Shakespeare's beliefs and his likes and dislikes through his imagery.

Some modern critics have used psychological theory to try to penetrate the surface of the action and understand the subconscious motives of both the characters and the author. Ernest Jones, a psychoanalyst, took this approach in *Hamlet and Oedipus* (1949). Jones's book helped shape many interpretations of the plays on the modern stage and in film versions.

Jan Kott, a Polish critic, wrote an unusual study of the plays called *Shakespeare Our Contemporary* (1964). In this work, he tried to approach Shakespeare's plays from the pessimistic point of view of much literature of the mid-1900's.



Mrs. Siddons and J. P. Kemble in the Dagger Scene from *Macbeth* (1806), an oil painting on canvas by Thomas Beach; Garrick Club, London

Sarah Siddons was England's leading Shakespearean actress of the late 1700's and early 1800's. She often performed with her brother John Philip Kemble in *Macbeth*, above.

Shakespeare's own acting company gave the first performances of his plays. The company had a number of talented actors, including Robert Armin, Richard Burbage, Will Kempe, John Lowin, and Joseph Taylor. Burbage ranks as the first great Shakespearean tragic actor. Shakespeare, in fact, created most of his great tragic roles for him.

The Restoration period. In 1642, civil war broke out in England, and Parliament closed the theatres. The Puritans, a stern religious and political group, gained control of the government and kept the theatres closed. In 1649, the Puritans beheaded the king, and England became a republic. But the people disliked Puritan rule, and Parliament restored the monarchy in 1660 under Charles II. This period in English history is called the Restoration. Charles reopened the theatres, and productions of Shakespeare and other playwrights resumed and flourished again.

During the Restoration period, changes occurred in the production of plays. For example, painted scenery became popular, and women replaced boys in female roles. At the same time, dramatists thought that Shakespeare's plays needed to be "improved." For example, Sir Thomas Davenant, with John Dryden's help, added characters to *The Tempest*, and Nahum Tate gave the tragedy *King Lear* a happy ending. Colley Cibber cut the text of *Richard III* severely and added material from Shakespeare's other histories. Many such altered versions remained popular for years.

Although Restoration dramatists lacked respect for Shakespeare's texts, the period produced one of histo-

ry's greatest Shakespearean actors, Thomas Betterton. Betterton was particularly noted for his interpretations of Hamlet, Macbeth, and Othello.

The Age of Garrick. The death of Betterton in 1710 marked the end of the Restoration era in English acting. A new era began in 1741 with the appearance of David Garrick on the English stage. Garrick became the most celebrated actor of his time and the first English actor to be accepted into upper-class society. He won fame for his natural but forceful style of acting and excelled in many roles, especially Hamlet and Richard III. In spite of his devotion to Shakespeare's works, Garrick acted in versions of the plays that differed greatly from the original texts.

Another famous Shakespearean actor of the 1700's was John Philip Kemble, who made his London debut in 1783. He became noted for his controlled, intellectual style. But Kemble was overshadowed by his sister Sarah Siddons, generally considered history's greatest Shakespearean actress. She was a passionate yet controlled performer. Her Queen Katherine in *Henry VIII* and Lady Macbeth especially impressed audiences.

The 1800's. The first great Shakespearean actor to make his debut in the 1800's was the English actor Edmund Kean. An intense, unconventional, and romantic performer, he introduced a more passionate style of acting. According to the English critic Samuel Taylor Coleridge, Kean's acting was like reading Shakespeare by "flashes of lightning." Kean's greatest roles were Othello and Richard III.

William Charles Macready, an English actor and theatre manager, fought to restore Shakespeare's texts to their original form. Unlike most of the actors who preceded him, Macready had a fundamental respect for Shakespeare's abilities as a playwright. In 1838, he produced a *King Lear* that restored an essentially Shakespearean text to the stage for the first time since the late 1600's. Macready also rejected Davenant and Dryden's adaptation of *The Tempest* in favour of Shakespeare's original text.

Sir Henry Irving dominated Shakespearean production in the late 1800's. Irving was the leading English actor of his day. He also became famous for his elabo-



Great Shakespearean actors of the 1800's included Sir Henry Irving of England and Edwin Booth of the United States. Irving was famous for his role as Shylock in *The Merchant of Venice*, left. Booth often played the evil Iago in *Othello*, right.



Laurence Olivier, far left, became one of the greatest Shakespearean actors of the 1900's. In addition to his stage performances, the British actor directed and starred in motion-picture versions of *Henry V*, *Hamlet*, and *Richard III*. This scene from *Richard III* shows Olivier as Richard with Sir Ralph Richardson, who played the Duke of Buckingham.

rate productions of Shakespeare's plays. Audiences of his time found it difficult to visualize any other actor as Hamlet or Shylock. Irving's leading lady, Ellen Terry, also became immensely popular.

Modern performances. As early as the 1880's, the English actor and producer William Poel had begun a movement to simplify Shakespearean productions. He staged the plays as Shakespeare wrote them and tried to re-create the conditions of Elizabethan productions. Lillian Baylis, an English theatre manager, established a Shakespearean acting company at the Old Vic Theatre in London in 1914. The Old Vic was the world's leading Shakespearean company until it was absorbed in 1963 into a new company now called the Royal National Theatre Company.

In the 1900's, the English theatre has produced many outstanding Shakespearean performers. Leading actors include Richard Burton, Maurice Evans, Sir John Gielgud, Laurence Olivier, Sir Michael Redgrave, Sir Ralph Richardson, and Paul Scofield. Important Shakespearean actresses include Dame Peggy Ashcroft, Claire Bloom, Dame Edith Evans, and Vanessa Redgrave. The American theatre has also produced a number of famous Shakespearean performers in the 1900's. They include John Barrymore, Katharine Cornell, Walter Hampden, and Orson Welles. Noted Canadian performers of world fame include Christopher Plummer, Douglas Rain, and Kate Reid.

Many films have been made of Shakespeare's plays. The most notable include Olivier's versions of *Henry V* (1944), *Hamlet* (1948), and *Richard III* (1955) and the Italian director Franco Zeffirelli's production of *Romeo and Juliet* (1968).

The plays have provided the basis for famous operas,

notably Giuseppe Verdi's *Otello* and *Falstaff*. Several modern musicals have been adapted from the plays, including Leonard Bernstein's *West Side Story* (*Romeo and Juliet*), Cole Porter's *Kiss Me, Kate* (*The Taming of the Shrew*), and Rodgers and Hart's *The Boys from Syracuse* (*The Comedy of Errors*).

Today, a number of theatre organizations present Shakespeare's plays. In England, the Royal Shakespeare Company performs in London and Stratford-upon-Avon. The Royal National Theatre in London presents Shakespeare regularly. In Canada, a Shakespearean festival is held each year in Stratford, Ontario.

Study aids

Related articles in World Book include:

Directors and performers

Aldridge, Ira
Anderson, Dame Judith
Barrymore (family)
Campbell, Mrs. Patrick
Garrick, David
Gielgud, Sir John
Granville-Barker, Harley
Guthrie, Sir Tyrone

Kean, Edmund
Olivier, Laurence
Reinhardt, Max
Robeson, Paul
Siddons, Sarah Kemble
Terry, Dame Ellen Alicia
Welles, Orson

Other related articles

Blank verse
Drama (Elizabethan and Stuart
drama)
Elizabeth I
English literature (The beginning
of modern English)
Folger Shakespeare Library
Globe Theatre

Holinshead's Chronicles
Macbeth
Poetry (Forms)
Stratford-upon-Avon

Outline

- I. **Shakespeare's life**
 - A. His life in Stratford
 - B. Early career in London
 - C. The years of fame
 - D. His last years
 - E. The anti-Stratfordians
- II. **England of Shakespeare's day**
 - A. Shakespeare's London
 - B. Elizabethan society
 - C. The English ruler
- III. **The Elizabethan theatre**
 - A. Theatre buildings
 - B. The stage
 - C. Scenic effects
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 - E. Acting companies
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 - A. The first period (1590-1594)
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- V. **Shakespeare's poems**
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- VII. **Publishing history**
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 - A. Neoclassical criticism
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- IX. **Performances of the plays**
 - A. The Restoration Period
 - B. The Age of Garrick
 - C. The 1800's
 - D. Modern performances

Questions

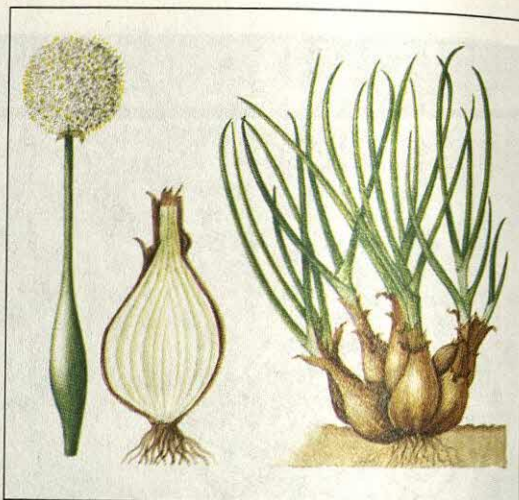
- Why are *Measure for Measure* and *All's Well That Ends Well* called *problem comedies*?
- How has Shakespeare influenced the English language?
- What are the most common themes of Shakespeare's sonnets?
- How did public and private theatres differ in Shakespeare's day?
- Why has there been any question about the authorship of Shakespeare's plays?
- What part did the Wars of the Roses play in Shakespeare's histories?
- What attitude did the romantic critics have toward Shakespeare and his plays?
- Into what three groups are Shakespeare's plays traditionally divided? What is an example from each group?
- Why did Shakespeare turn to writing narrative poetry in the early 1590's?
- Who was Richard Burbage? David Garrick? Sarah Siddons?

Shaking palsy. See **Parkinson's disease**.

Shale is a fine-grained sedimentary rock formed by the compression of muds. It is composed chiefly of quartz and minerals found in clay. Shales can be broken easily into thin, parallel layers. Shale is ground up for use in making bricks and cement. See also **Oil shale**; **Sedimentary rock**; **Slate**.

Shallot is a vegetable that looks and tastes like an onion, but has a more delicate flavour. People eat shallots in salads and use them as seasoning for cooked foods. The entire plant is edible, including its leaves, stems, and bulb. The bulb consists of several small sections called *cloves*, which are joined at the base of the plant.

Shallot plants can grow from year to year without replanting. But most commercial producers grow shallots by replanting bulbs from the previous harvest. The



The shallot looks and tastes like an onion. Its bulb consists of sections called *cloves* joined at the plant's base, right.

bulbs are harvested in the winter or spring. They are then dried and stored until they are replanted.

Two varieties are the true shallot, about the size of a walnut and grown chiefly for pickling and the Jersey or false shallot, which has a larger, rounder bulb.

Scientific classification. The shallot is considered a member of either the amaryllis family, Amaryllidaceae, or the lily family, Liliaceae. It is *Allium ascalonicum*.

Shaman is a person considered to have certain powers that come from direct contact with the supernatural, often in dreams or trances. The term came from a Mongolian word, but peoples in many areas have shamans who they believe cast out evil spirits or bring good, especially by curing disease. Shamans may be found among the Eskimos, Maoris, Mongolians, Polynesians, and others. American Indians had similar beliefs (see **Indian, American** [Shamans]).

Shamir, Yitzhak (1915-), served as prime minister of Israel from October 1983 to September 1984 and from October 1986 to July 1992.

Shamir succeeded Menachem Begin as prime minister in 1983, after Begin had resigned. He also replaced Begin as head of the political party called the Likud bloc. Shamir had been foreign minister since 1980.

In July 1984, parliamentary elections were held in Israel. No party won a majority. In September, the Likud bloc and the Labour Party formed a unity government that lasted for 50 months. Under the unity government agreement, Shimon Peres, leader of the Labour Party, served as prime minister for 25 months. Shamir served as vice prime minister and foreign minister. Under the agreement, the roles of Peres and Shamir were reversed after 25 months—in October 1986. In the elections of November 1988, no party won a majority. In December, Likud and Labour formed a new coalition government. Shamir remained prime minister.

As prime minister, Shamir continued most of Israel's previously established foreign policies. For example, he supported Jewish settlements in the West Bank and Gaza Strip—Israeli-occupied territories. In 1988, protests

by Palestinians in the occupied territories erupted into violence. Israeli troops killed a number of protesters. In 1990, Shamir refused to compromise on peace plans for the occupied territories. The Labour Party then left the coalition, and the government fell in March. In June 1990, Likud and small conservative parties formed a new coalition government in Israel with Shamir as prime minister. Shamir lost office when his party was defeated in the June 1992 general election.



Yitzhak Shamir

Shamir was born in Ruzinoy, a village in eastern Poland. His last name was Jazernicki. He later changed his name to Shamir, the Hebrew word for both *thistle* and *flint*. He studied law in Warsaw before moving to Palestine in 1935 to attend Hebrew University. He dropped out in 1937 and joined the Irgun Zvai Leumi, an underground Jewish militia organization that fought the British—who then ruled Palestine—and the Palestinian Arabs. In 1940, he joined the more radical Lohamei Herut Yisrael (Israel Freedom Fighters), or Stern Gang, militia. From 1955 to 1965, Shamir worked for Mossad, Israel's intelligence agency.

Shampoo. See **Hairdressing** (Caring for the hair).

Shamrock is a type of small herb with leaves made up of three leaflets. It is the national symbol of Ireland. According to legend, Saint Patrick planted shamrock in Ireland because the three small leaflets represented the Holy Trinity. Many Irish people wear a shamrock on St. Patrick's Day. The name *shamrock* comes from an Irish word that means *trefoil* (three-leafed).

In Ireland, the plant most often referred to as shamrock is the *white clover* although the traditional shamrock is believed to be the black medic *Medicago lupulina*. This plant has slender, creeping stems and white or pinkish-white flowers. Other plants sometimes referred to as shamrock include *red clover*. Florists often sell *wood sorrel* as shamrock, but this plant is generally not considered the true shamrock.



Shamrock

Scientific classification. White clover, black medic, and red clover belong to the pea family, Leguminosae (Fabaceae). White clover is *Trifolium repens*, black medic is *Medicago lupulina*, and red clover is *Trifolium pratense*. Wood sorrel is in the oxalis family, Oxalidaceae. It is *Oxalis acetosella*.

Shang dynasty was the earliest known Chinese dynasty (family of rulers). The dynasty governed from about 1766 B.C. to about 1122 B.C. It was centred in what is now northern Henan Province.

The Shang society, though based on agriculture, be-

came famous for its fine carvings and bronze work. Most Shang relics found by scientists came from Anyang, a Shang capital. Anyang had houses, palaces, temples, and elaborate tombs.

The people of the Shang period used bronze to make vessels, weapons, and chariot fixtures. They also carved marble and jade and wove silk. The Shang writing system had more than 3,000 symbols. It appears on pieces of bone and turtle shells. The people used oracle bones to ask the spirits of their ancestors about such future occurrences as crop growing, hunting trips, and wars.

The Shang society was headed by a priest-king and had two classes of people—commoners and nobles. The people worshipped their ancestors and had many gods. The two chief gods were what the people called a Ruler Above and a God of Earth.

See also **China** (History [map]).

Shanghai (pop. 8,214,436) is the largest city in China. It lies on the Huangpu River. For location, see **China** (political map). About 23 kilometres north of Shanghai, the Huangpu and Yangtze rivers meet and empty into the East China Sea. Shanghai's location near these important waterways helps make it China's leading port and industrial city.

Shanghai was a small trading town until the 1800's. In 1842, the United Kingdom forced China to open it to foreign trade. People from France, the United Kingdom, the United States, and other countries settled in Shanghai and gained great power in the city's affairs. They made it a world leader in trading and banking. They built many homes, churches, and office buildings, which gave much of Shanghai a Western appearance. The Chinese Communists took over Shanghai and the rest of China in 1949.

The city. Shanghai lies within the Shanghai special municipal district, which has a population of about 12 million. The district has three main parts. They are (1) the old foreign section in the north, (2) the original Chinese settlement in the south, and (3) suburban areas around these two sections.

The heart of Shanghai lies in the old foreign section,



The busy streets of Shanghai, the largest city in China, are crowded with pedestrians. Nanjing Road in northern Shanghai, above, is one of the city's main streets.



Shanghai's harbour bustles with activity. Shanghai, China's largest city, is a leading port and industrial centre. Boats carry products made in the city's factories to the interior of China by way of the Yangtze River.

near the intersection of the Bund and Nanjing Road. The Bund, a broad boulevard near the Huangpu River, has skyscrapers built in the 1920's on one side and public gardens on the other side. Wharves and shipyards line the river beyond the gardens. Many shops and restaurants lie along Nanjing Road. An old British race track on the road has been made a sports stadium. Many skyscrapers in the foreign section now stand empty or serve as schools. Chinese families live in residential areas where foreigners used to live.

The original Chinese settlement, sometimes called the "Chinese City," lies south of the foreign section. It has residential and commercial buildings and narrow, twisting streets. Since the 1950's, the Communist government has built 11 suburbs around old Shanghai. These suburbs include flats, factories, farms, schools, and shops.

Almost all the people of Shanghai are Chinese. Most of them work in factories and earn enough to be able to eat and dress well by Chinese standards. The city has many universities and research centres.

Economy. Shanghai lies in one of China's most important industrial areas. Iron mines west of the city help supply raw material for the manufacture of machinery and for shipbuilding. Textile mills make cloth from cotton grown in the nearby Yangtze Valley or from imported cotton. Other products include cement, electrical equipment, and fertilizer. Farmers in suburbs grow cereals, cotton, and vegetables. They also rear pigs and fish.

Government. Shanghai lies in Jiangsu Province, but its government is independent of the provincial government. From 1949 until the mid-1960's, a committee of the Chinese Communist Party made policies for the city that local civilian leaders carried out. In the mid-1960's, a committee directed by China's army took control of the government. In 1979, the city was returned to civilian rule.

History. Shanghai developed as a small trading centre during the Song dynasty (960-1279). In 1842—at the end of the so-called "Opium War" between China and Great Britain—Britain forced China to open the town to foreign trade. Other nations soon gained trading rights, and Shanghai became a major trading centre. British, French, Japanese, and U.S. citizens settled there in special areas for foreigners called *concessions*.

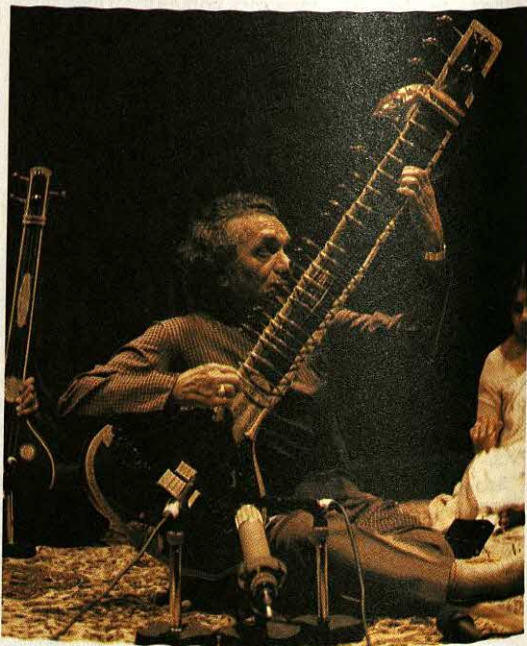
Foreigners and some Chinese business people set up banks and businesses in Shanghai. Many Chinese peasants moved to the city to find jobs. Most Chinese workers lived in slums in the old part of the city.

During the early 1900's, merchants, students, and workers protested against foreign influence. Some of them founded China's Communist Party in Shanghai in 1921. In 1927, the Chinese Nationalists killed many Chinese Communists and drove others from the city.

The Japanese captured Shanghai in 1937. They occupied the city until World War II ended in 1945. Great Britain and the United States gave up their concessions in Shanghai during the war, and France gave up its concession in 1946.

The Communists conquered China in 1949. They enlarged Shanghai and developed heavy industries. In 1966, Communist Party Chairman Mao Zedong called for a "cultural revolution" to rid the party of his enemies. As part of this revolution, *Red Guards* (student supporters of Mao) drove the Shanghai government from power. The city soon came under control of a committee directed by the army. It was returned to civilian rule in 1979.

Shankar, Ravi (1920-), an Indian musician, became well known throughout the world for his inspired playing of the *sitar* (see *Sitar*).



Ravi Shankar is celebrated throughout the world for his playing of the sitar. He is also known for his compositions, including concertos for sitar and orchestra.

Ravi Shankar was born in Benares, now the city of Varanasi, Uttar Pradesh. He began his career as a dancer and accompanist in the dance troupe of his brother Uday. From the age of 18, he spent seven years mastering the sitar. He served as music director of All-India Radio from 1948 to 1956. He composed the film scores for the Indian film director Satyajit Ray's *Apu* trilogy. The three films were made between 1955 and 1959 (see Ray, Satyajit).

In 1956, Ravi Shankar became the first Indian instrumentalist to go on a world tour. In 1962, he founded the Kinnara School of Music in Bombay, his adopted home.

During the 1960's, Shankar stimulated interest in Indian music abroad. George Harrison, a member of the Beatles pop group, became one of his best-known pupils. In 1969, Shankar went to Woodstock in the United States and took part in a famous rock concert. In the same year he published his autobiography, *My Life, My Music*. His classical compositions include concertos for sitar and orchestra, which appeared in 1971 and 1976.

Shankaracharya (A.D. 700?-750?), also known as Shankara, was a Hindu philosopher. His most important works were his commentaries on the *Vedas*, the sacred writings of Hinduism. Shankaracharya was born in Kerala, south India. He practised self-denial and learnt to give up worldly pleasures and comforts early in life. He devoted himself to study, philosophical discussion, and religious teaching. The fame of this wandering scholar spread throughout India. During his journeying, Shankaracharya established four great monasteries—at Badrinath in the Himalaya, Shringeri in Mysore, Dwarka in western India, and Puri in eastern India.

Shankaracharya's philosophy formed the basis for much that is richest in Hindu belief. To him, the oneness of all creation with *Brahman* (God) was the only truth. He perceived Brahman, creative source of all things, as pure thought, formless, and without attributes. Only by understanding that God alone is real can each individual soul be united to God after death. Because all things exist through God and in God, after death each soul returns to be part of God. This became the foundation of Shankaracharya's philosophy.

Shannon. See Munster.

Shannon, River, is the chief waterway of the Republic of Ireland and the longest river in the British Isles. It rises in the Cuilcagh Mountains of northwestern Ireland and flows southwest for about 370 kilometres to the Atlantic Ocean (see Ireland [map]). Three major *loughs* (lakes)—Allen, Ree, and Derg—lie along the river's course. At the city of Limerick, about 110 kilometres from the mouth of the Shannon, the river widens. Ocean tides occur in this wide section, on which there are ports at Limerick and Foynes. The river is a major waterway for pleasure cruising.

The Shannon flows mainly through gently sloping farmland and scattered *peat bogs* (former swamps composed of partly decayed plants). It often floods surrounding land. Ireland's largest river hydroelectric plant was built on the Shannon between Lough Derg and Limerick in the 1920's. The Grand and Royal canals, built in the late 1700's and early 1800's, link the river with Dublin, on Ireland's east coast.

SHAPE, or Supreme Headquarters Allied Powers Europe. See North Atlantic Treaty Organization.

Shapley, Harlow (1885-1972), was an American astronomer. He made important studies of *variable stars* (stars that change in brightness) and the spherical stellar groups in which they frequently occur. His research on these star groups, called *globular clusters*, contributed much to knowledge about the Milky Way and other galaxies, such as the Magellanic Clouds.

Shapley was born in Nashville, Missouri, U.S.A., and received his Ph.D. degree from Princeton University in 1913. He served as director of the Harvard Observatory from 1921 to 1952.

Shar-pei is a breed of dog that originated in China about 200 B.C. It is also known as the *Chinese shar-pei*. This compact dog has short ears and a short, harsh coat of a solid colour. Its skin is loose and wrinkles cover the head, neck, and shoulders. The skin of puppies is especially loose and wrinkled. Most shar-peis stand 46 to 51 centimetres tall at the shoulder and weigh 18 to 25 kilograms. The tongue is blue-black. Shar-peis originally were used as guard dogs and later may have been bred for fighting. They are alert, independent, intelligent, and extremely loyal.

See also **Dog** (picture: Some breeds of dogs).

Sharaku was a great Japanese artist of the late 1700's. Sharaku's reputation rests on colour woodcuts of Japanese actors that he created in 1794 and 1795. Nothing is



Portrait of Bando Mitsugoro (1794 or 1795); Tokyo National Museum

A Sharaku woodcut portrays a Japanese actor playing a role in a kabuki drama. A typical Sharaku print exaggerates an actor's facial features and posture to capture the spirit of the role.

known of his life before and after these years or why his career was so short. Sharaku was the artist's professional name. His real name is unknown.

Sharaku portrayed actors of the Japanese *kabuki* drama playing their roles. Most of his prints are head portraits but some show full-length figures. Sharaku exaggerated the facial features and distorted the postures of his subjects. His prints capture not only the likenesses of the actors, but also the spirit of their dramatic roles. Sharaku seldom included background settings in his prints. Instead, the subjects stand out vividly against a dull-coloured background.

See also **Japanese print** (picture); **Woodcut**.

Share. See **Stocks and shares**.

Sharecropper. See **Plantation**.

Sharif, Omar (1932–), is the stage name of an Egyptian-born actor. He shot to stardom with his performance in the Academy Award-winning film, *Lawrence of Arabia* (1962). He confirmed his status when he played the title role in *Dr. Zhivago* (1965). Both films were made by the British director, David Lean. At first, Sharif was cast as the strong romantic hero, a stereotype he never entirely shook off. Later he extended his range to include light comedy. His personal interests have focused on bridge, at which he became a world-class player. He was born in Alexandria. His real name is Michael Shalhoub.

Shark is a meat-eating fish and one of the most feared sea animals. Scientists classify about 350 species of fish as sharks. These fish live in oceans throughout the world but are most common in warm seas.

Sharks vary greatly in size and habits. Whale sharks, the largest kind of shark—and the largest of all fish—may grow up to 12 metres long. They may weigh over 14 metric tons, more than twice as much as an African elephant. The smallest sharks may measure only 13 centimetres long and weigh about 28 grams. Some kinds of sharks live in the depths of the ocean. Others are found near the surface. Some species live in coastal waters, but others dwell far out at sea. A few species enter rivers and lakes that have outlets to the sea.

All sharks are *carnivores* (meat-eaters). Most of them eat live fish, including other sharks. In fact, a shark's most common natural enemy is a larger shark. Most sharks eat their prey whole, or they tear off large chunks of flesh. Some sharks crush their prey. Others scoop out small pieces of flesh from large fish. Sharks also feed on dead or dying animals.

Sharks have the reputation of attacking human beings. But fewer than 100 shark attacks a year are reported throughout the world.

The body of a shark

Sharks differ from most other kinds of fish in a number of ways. For example, sharks have a boneless skeleton made of a tough, elastic substance called *cartilage*. Most species of sharks have a rounded body, shaped somewhat like a torpedo. This streamlined shape aids in swimming. Angel sharks, which live near the ocean bottom, have a flat body similar to that of skates and rays.

Sharks have fewer young at a time than most fish do. Some species give birth to 60 or more *pups* in a litter, but most have far fewer. The parents do not take care of the young—and may even eat them.

Shark eggs, unlike those of most fish, are fertilized inside the female's body. The male shark has two organs called *claspers*, which release sperm into the female, where it fertilizes the eggs. Among most species of sharks, the eggs hatch inside the female, and the pups are born alive. At least 40 species lay their eggs outside their bodies.

Tail and fins. Sharks can travel with great bursts of speed when excited. Scientists recorded a blue shark travelling at a speed of 69 kilometres per hour. The fastest-swimming sharks have a crescent-shaped tail that provides power for swimming. The upper part of the tail usually is longer than the lower part. Stiff *pectoral* (side) fins help lift and balance the front of the body.

Most fish have a *swim bladder*, a gas-filled organ that helps them remain at a certain depth without sinking. Sharks lack this organ. Instead, they have a large liver filled with oil. This oil is lighter than water, and it helps keep the shark from sinking. Even so, sharks must swim constantly or they will sink.

Teeth and scales. A shark's mouth is on the underside of the head among all species except the angel, megamouth, whale, and wobbegong sharks. The mouth of these sharks is at the front of the head. A shark has several rows of teeth. New teeth replace the rows of old teeth regularly—as often as every one to two weeks. Some sharks have molarlike grinding teeth. Others have razorlike cutting teeth, and still others have pointed teeth. Some people believe that sharks must turn over on their back to bite, but this is not true.

Small, toothlike scales cover a shark's body. These *placoid* scales make the skin of a shark very rough. Dried sharkskin, called *shagreen*, was once used as sandpaper.

Gills. Sharks get oxygen from the water through gills, as do other fish. But sharks have no *gill cover*, a bony plate that shields the gills of most fish. Instead, sharks have from five to seven slits in the skin on each side of the head. Water passes out of these slits after the shark's gills remove the oxygen.

Most sharks cannot pump water over their gills, as do the majority of fish. Sharks rely on their constant swimming to force water through their mouth and over their gills. This process of forcing water is known as *ram-jet ventilation*.

Senses. Sharks have keen senses that enable them to compete successfully for prey. They have excellent hearing, though it is limited to low-pitched sounds. Sharks can home in on prey by its sounds. Some scientists believe that the shark's *lateral line* detects the lowest-pitched sounds. The lateral line is a sensory system of fluid-filled canals that runs down both sides of the shark's body, from its head to its tail. The lateral line also detects water movement.

Sharks have highly sensitive eyes that can see extremely well in dim light. Sharks even possess a crude form of colour vision. However, they may not be able to see details clearly. Sharks have been called "swimming noses." It was once widely believed that sharks relied mainly on their sense of smell to hunt prey. However, little evidence exists of a special sensitivity for smells in sharks.

Sharks can detect incredibly small electrical fields. The head of a shark has a large number of small pores



The oceanic whitetip shark, left, has a graceful, torpedolike body. The fish's streamlined shape enables it to move swiftly through the water with little effort. This shark is named for the white markings on the tips of its fins. It is one of the most common species of large shark. Note the sucker fish or remora attached to the shark's underside. There is also a small pilot fish swimming below.

that lead to an elaborate system of sensory tubes. These tubes, called *ampullae of Lorenzini*, are sensitive to electrical fields. Sharks can locate and capture a fish by sensing the small electrical field produced by its gills. Sharks also seem to use their electrical sense for navigation and migration.

Kinds of sharks

Sharks belong to a group of fishes known as *elasmobranchs*. Rays and skates also belong to this group. Scientists do not know exactly how many kinds of sharks there are. They frequently identify new species. But sometimes they find that two sharks that had been considered different species are actually the same. This section describes some of the best-known sharks.

Basking sharks may measure over 9 metres long and live in tropical, subtropical, and temperate waters. They eat only small animal and plant life called *plankton*. These sharks have a habit of slowly swimming on the surface. They seem to be *basking* (warming themselves), but they are actually filtering plankton from the surface.

Bull sharks can live in fresh water. They often enter rivers that empty into the sea. For example, bull sharks have been captured in the Amazon River in Brazil, in the

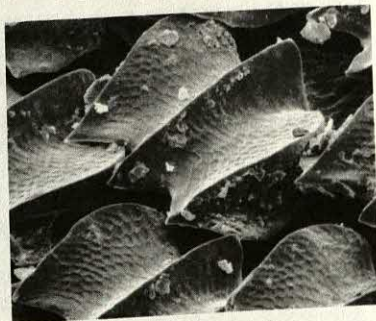
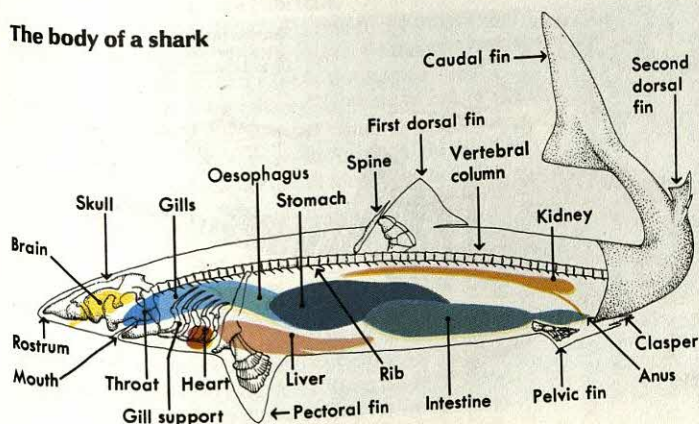
Ganges River in India, and in the Mississippi River in the United States. They are also found in Lake Jamor in Indonesia and in Lake Nicaragua in Nicaragua. Bull sharks often feed on other sharks and have attacked swimmers.

Hammerhead sharks, which include a number of similar species, rank among the strangest-looking sharks. They have a flattened head, which in most of the species resembles the head of a hammer. Their eyes and nostrils are at the ends of the "hammer." The largest hammerhead, the *great hammerhead*, is just over 6 metres long. Hammerheads live in shallow tropical and warm temperate waters and have attacked people.

Mako sharks are swift, powerful creatures. They are considered one of the best species of game fish among all the sharks. When hooked, a mako fights by leaping high into the air. Most makos live in tropical and warm temperate waters. They may reach a length of 3.5 metres. Makos feed on such fish as bluefish, herring, mackerel, and swordfish. Makos have attacked small fishing boats as well as swimmers.

Nurse sharks are slow-moving fish that may grow up to 4.5 metres long. They live among reefs in shallow tropical and subtropical waters. Unlike most species of sharks, the nurse shark can pump water over its gills.

The body of a shark



A shark's skin is covered with tiny toothlike scales. The scales pictured above were photographed with an electron microscope.



The mouth of a white shark has two rows of razor-sharp teeth. New teeth regularly replace the old teeth. The replacement teeth lie out of sight along the inside of the jaws.

Therefore, it does not have to swim constantly and often lies motionless on the sea bottom. Nurse sharks eat bottom-dwelling fish, crabs, lobsters, sea urchins, and shrimp. They have attacked people. But most of these attacks were caused by the victim, who foolishly grabbed a motionless nurse shark by the tail.

Thresher sharks are long-tailed subtropical fish that swim along the surface. They grow to a length of about 6 metres, of which half is the tail. The thresher uses its long tail to gather into "herds" the fish it feeds on and to stun fish before eating them. No thresher shark has been known to attack a person.

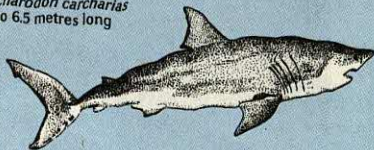
Wobbegongs are sharks that live in shallow coastal waters of Australia. They are most often found in caves and in hollows in coral reefs. Wobbegongs have a broad, flattened head, and a mouth fringed by fleshy barbels. The body is an overall brown colour patterned with light-edged spots and bars. Wobbegong grow to over 3 metres in length. They are dangerous when disturbed.

Whale sharks, in spite of their enormous size, eat only plankton and small fish. Therefore, they are harmless to people. Whale sharks live in tropical waters.

White sharks rank among the most dangerous sharks. They measure up to 6.5 metres long and live in cool temperate to tropical waters. White sharks swim powerfully and prey on such large animals as sea lions, tuna, and other sharks. They have attacked human beings and even fishing boats.

Some kinds of sharks

White shark
Carcharodon carcharias
Up to 6.5 metres long



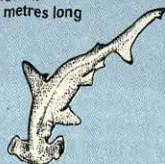
Nurse shark
Ginglymostoma cirratum
Up to 4.5 metres long



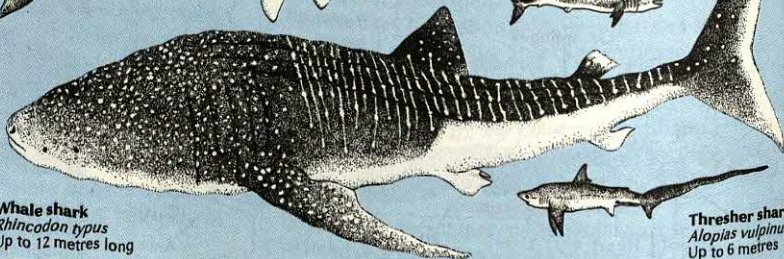
Shortfin mako
Isurus paucus
Up to 3.5 metres long



Scalloped shark
Sphyrna tiburo
Up to 4.5 metres long



Whale shark
Rhincodon typus
Up to 12 metres long



Thresher shark
Alopias vulpinus
Up to 6 metres long



Tiger sharks are aggressive sharks that live in tropical and subtropical seas. They get their name from the dark body stripes, though large individuals are not usually patterned. They have a well-defined scythe-shaped tail. They grow to over 5 metres long and may weigh up to 800 kilograms. Tiger sharks feed on a great range of prey, including dolphins, sea turtles, fish, and crabs. They have been responsible for many attacks on human beings.

Sharks and people

Shark attacks. About a seventh of the approximately 350 species of sharks are considered potentially dangerous to human beings. Most shark attacks do not result in death or serious injury. However, swimmers should take special care in areas known to have sharks.

People once thought that sharks ate constantly and would attack any human being immediately. But scientists have learned that some species of sharks can go for days or weeks without feeding. During this time, the oil stored in their liver probably nourishes them.

Scientists do not know why sharks sometimes attack people and at other times leave them alone. General rules for swimming in shark-infested waters include:

- (1) Never swim or dive alone.
- (2) Never swim or dive with an open wound. Blood attracts sharks.
- (3) Never swim or dive at night or in dirty water, where there is less chance of spotting a shark.
- (4) Leave the water immediately if a shark is sighted. Swim as smoothly as possible because thrashing movements might attract the shark.
- (5) Never grab or injure any shark, even a small and apparently harmless one.

How people use sharks. Commercial fishing crews catch sharks mainly for their hides, fins, and flesh. Shark hide makes an especially luxurious leather after the scales have been removed from it. Chinese people often use dried shark fins in making a popular and expensive soup.

People in various parts of the world eat the flesh of many species of sharks. In Great Britain, for example, small members of the shark group, known as dogfish, are often used in preparing *fish and chips*. The fish is known as *rock salmon*.

The liver oil of certain species of sharks contains large amounts of vitamin A. Until the late 1940's, shark liver oil was a main source of vitamin A.

Since the late 1950's, sharks have been used increasingly in scientific research. Medical researchers are particularly interested in the fact that few sharks have ever been found with a cancerous tumour.

Scientific classification. Sharks belong to the class Chondrichthyes. Basking, mako, and white sharks are in the family Lamnidae; hammerhead sharks, the family Sphyrnidae; thresher sharks, the family Alopiidae; and whale sharks, the family Rhinodontidae. Bull sharks and the tiger shark are in the family Carcharhinidae. Nurse sharks are in the family Orectolobidae. Wobegongs are in the family Orectolobidae.

See also **Animal** (picture: Animals of the oceans); **Dogfish**; **Fish**, with pictures; **Ray**; **Remora**.

Shark Bay is an inlet on the western coast of Western Australia, about 676 kilometres north of Perth. For location, see **Western Australia** (map). Shark Bay is about 240 kilometres long and 97 kilometres wide. Peron Peninsula extends into the centre of the bay. Dirk Hartog, Bernier, and Dorre islands lie at the mouth of Shark Bay.

Shark sucker. See **Remora**; **Symbiosis**.

Sharma, Shankar Dayal (1918-), a Congress Party politician and lawyer, became president of India on July 26, 1992. He had served as vice-president since 1987.

Sharma studied and later taught law at the universities of Lucknow in India, Cambridge in the United Kingdom, and Harvard in the United States. From 1950 to 1952 he served as president of the Bhopal State Congress Committee, and in 1952, he became chief minister of the state of Bhopal. In 1956, when Bhopal merged with the state of Madhya Pradesh, he was appointed a cabinet minister for the state. In 1971, Sharma was elected to *Lok Sabha* (the lower house of the parliament of India) and from 1974 to 1977 he served as minister of communications. During the 1980's, he served as governor of Andhra Pradesh and Punjab.

Sharon, Rose of. See **Hibiscus**.

Sharp, Cecil (1859-1924), was one of the most important collectors of English folk music. He travelled widely throughout England, and later in the Appalachian Mountains in the United States, listening to folk music. Sharp was born in London. After completing his education, he lived for several years in Australia. He returned to England and became a school music teacher. He believed that the exclusively German tradition of music taught in schools of the time should be supplemented by some British music. This idea led him to begin his folk music researches.

Sharp, Granville (1735-1813), was a leader of the movement for the abolition of slavery in Britain. In 1772, his efforts resulted in the legal decision that as soon as any slave sets foot on British territory, he or she becomes free. His proposal of a colony for freed slaves

was put into effect at Sierra Leone in 1787. He campaigned against press gangs and helped found the British and Foreign Bible Society in 1804. Sharp was born in Durham, England.

Shastri, Lal Bahadur (1904-1966), was India's second prime minister, serving from 1964 until his death. Shastri was born near Varanasi. His early life was devoted to India's struggle for independence, during which the British imprisoned him seven times.

Jawaharlal Nehru soon recognized Shastri's talents as a political organizer and gave him many responsibilities, including the post of general secretary of the Congress Party. For many years, he served in the cabinet of Nehru, India's first prime minister. After Nehru's death in 1964, Shastri succeeded him as prime minister.

In 1965, during Shastri's period of office, India went to war with Pakistan. In January 1966, after a UN-sponsored cease-fire, he travelled to Tashkent, in what was then the Soviet Union, to negotiate an agreement with Ayub Khan, the Pakistan leader. The day after the agreement was signed, Shastri died of a heart attack.

Shavuot is a Jewish festival that celebrates the day the Ten Commandments—the foundation of Jewish written and oral law—were revealed to Moses on Mount Sinai. It falls in May or June, on the sixth day of the Hebrew month of Sivan. Orthodox and Conservative Jews outside Israel observe Shavuot for two days. The holiday is also called Feast of Weeks because it comes seven weeks, or "a week of weeks," after the first day of Passover (see **Passover**).

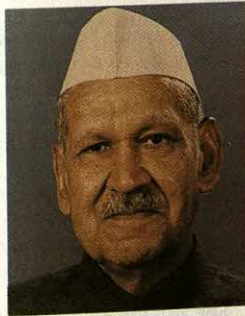
The ancient Hebrews celebrated Shavuot as a harvest festival. They made pilgrimages to Jerusalem to offer sacrifices at the Temple. During the festival today, Jews read the Book of Ruth from the Bible. The book is set during the spring harvest. According to one tradition, the book is read because King David, a descendant of Ruth, died on Shavuot.

Shaw, George Bernard (1856-1950), an Irish-born dramatist, critic, and essayist, ranks as one of the most important literary figures of the 1900's. He won the Nobel Prize for literature in 1925.

Shaw disliked the romantic and sentimental Victorian theatre of the late 1800's. Influenced by the revolutionary social dramas of the Norwegian playwright Henrik Ibsen, he viewed the theatre as a platform for supporting social reform. In a remarkable career that covered nearly 60 years, he wrote over 50 plays. Most of them are comedies in which a debate on ethics is as important as such traditional dramatic values as characterization and appealing to the emotions of an audience.

Shaw was an original thinker. He defended women's rights, became a vegetarian, and promoted a simplified alphabet. He defended his opinions in a series of essays, many published as prefaces to his plays. Like the plays, the essays are charming for their brilliance and wit.

Early life. Shaw was born in Dublin on July 26, 1856. He moved to London in 1876, and became a successful music critic. In 1884, he helped found the Fabian Society, an organization of socialists who believed that political and economic change could be gained through reform. It was for the Fabian Society that Shaw prepared a famous lecture on Ibsen, later published as *The Quintessence of Ibsenism* (1891). Because of their radical nature, Shaw's early plays did not become popular imme-



Shankar Dayal Sharma

diately in London. His first play, *Widower's Houses* (1892), attacked slum landlords. *Mrs. Warren's Profession*, which deals with the causes of prostitution, was written in 1893. But it was not produced until 1902, and then was immediately banned. *Arms and the Man* (1894), an antiwar comedy, was only mildly successful when it opened.

Mature period. Public hostility to Shaw began to disappear after 1904, when his friend Harley Granville-Barker produced 11 of his plays in less than three years at the Royal Court Theatre. These included *Candida* (1895), *The Devil's Disciple* (1897), *Caesar and Cleopatra* (1898), and *Man and Superman* (1903). This last play contains the celebrated scene "Don Juan in Hell," which is often performed as a separate work.

Man and Superman introduced Shaw's theory of what he called the "life force." To Shaw, the "life force" was the energy that dominates people biologically. However, when harnessed by human will, the "life force" can lead to a higher, more creative existence. This concept is central to Shaw's most ambitious play, the five-part *Back to Methuselah* (1918-1920), a fable that traces the entire history of humanity.

Saint Joan (1923), a drama about the individual in conflict with historical necessity, is widely regarded as Shaw's masterpiece. But some critics prefer *Pygmalion* (1912). This ironic Cinderella story describes how a professor of *phonetics* (speech sounds) demonstrates the absurdity of class distinctions by changing an ignorant Cockney girl into a counterfeit aristocrat by changing her speech (see *Pygmalion*). The play was adapted into the musical *My Fair Lady* (1956). Shaw's other plays include *Major Barbara* (1905), *The Doctor's Dilemma* (1906), *Androcles and the Lion* (1913), and *Heartbreak House* (1919).

Shaw, Irwin (1913-1984), was an American novelist, short-story writer, and dramatist. Many of his works involve political issues. Shaw portrayed life in the United States as an intense struggle against the moral sickness he saw in modern American society. Shaw's works also show his outstanding ability to describe American character types.

Shaw's first novel, *The Young Lions* (1948), deals with the historical significance and horror of World War II (1939-1945). In later novels, he explored such themes as Communism and civil rights. Two related novels, *Rich Man, Poor Man* (1970) and *Beggarman, Thief* (1977), are set against a background of social and political events from the mid-1940's to the late 1960's. *Nightwork* (1975) is Shaw's only comic novel. His other novels include *Two Weeks in Another Town* (1960); *Evening in Byzantium* (1973); *Bread Upon the Waters* (1981); and *Acceptable Losses* (1982). Shaw published several collections of short stories. Many stories from these collections appear in *Short Stories: Five Decades* (1978).

Shaw was born in New York City. He first gained recognition with the antiwar play *Bury the Dead* (1936). Shaw settled in Europe in 1951.

Shaw, Robert (1916-), an American conductor, is one of the outstanding choral conductors of his time. His choruses are known for their technical skill and the vitality of their singing. Shaw excels with highly dramatic works that require large choruses.

Shaw was born in Red Bluff, California, U.S.A. He

achieved his first musical success with the Collegiate Chorale, which he organized in 1941. In 1948, he formed the Robert Shaw Chorale. Shaw is also a noted orchestra conductor. He conducted the San Diego Symphony Orchestra from 1953 to 1958. Shaw served as associate conductor of the Cleveland Symphony from 1956 to 1967, when he became musical director of the Atlanta Symphony.

Shaw, Runme (1901-1985), a Chinese film producer, headed the Shaw Brothers Organization. This company owned film studios in Hong Kong, and 140 cinemas in Southeast Asia.

Runme Shaw was born in Shanghai, China. In 1924, he went to Singapore, where he built his first cinema in 1932. He became a well-known philanthropist. In 1948, he started the tradition of giving *angpows* (red envelopes containing money) to the aged poor. In 1958, he set up the Shaw Foundation as a charitable organization.

In 1977, Runme Shaw was awarded the Singapore Meritorious Service Medal in recognition of his work on numerous voluntary committees. In 1982, he was given the Dag Hammarskjöld award in the humanity and arts category.

Shawnee Prophet (1775?-1837?) was a Shawnee Indian religious leader. He and the Shawnee chief Tecumseh, who were brothers, united the Indians of North America from many tribes to defend their land against whites.

The Shawnee Prophet was called Laulewasika during his early life. As a young man, he became an alcoholic. About 1805, he had visions that convinced him to stop drinking and begin preaching. He changed his name to Tenskwatawa, which means *the open door*. Tenskwatawa urged Indians to give up alcohol and return to their traditional ways of life.

Whites named him the Shawnee Prophet because they thought he predicted events. The Prophet lost most of his followers after he was defeated in the Battle of Tippecanoe in 1811.

See also **Indian wars** (Other Midwestern conflicts). **Sheares, Benjamin Henry** (1907-1981), a distinguished doctor, served as second president of Singapore from 1971 to 1978. He was the first Singaporean to specialize in the field of women's health and became known as his country's "father of modern obstetrics and gynaecology." See **Obstetrics and gynaecology**.

Sheares was born in Singapore and educated at the Raffles Institution. He studied medicine at the King Edward VII College of Medicine in 1923. He began his medical career in obstetrics and gynaecology in 1931. In 1948, he obtained membership of the Royal College of Obstetricians and Gynaecologists in the United Kingdom.

During the Japanese occupation of Singapore from 1942 to 1945, Shaw was head of the department of obstetrics and gynaecology at Kandang Kerbau Hospital. He was appointed to the post of professor of obstetrics and gynaecology of the University of Malaya after the war. In 1960, he perfected operational procedures, which became known throughout the medical world as *the Sheares' operation*. He continued teaching during his two terms as president of Singapore in the 1970's. Sheares served as chancellor of the National University of Singapore from 1980 until his death.



Sheep shearers work carefully to remove the wool from sheep. Using electrically powered clippers, an expert shearer can fleece 200 or more sheep in a day.

Shearing is the removal of the fleece from a sheep or similar wool-bearing animal (see **Wool**). In most parts of the world, sheep are shorn once a year. A shearer aims to remove the fleece in one piece. Most modern shearers use electrically powered clippers to remove the fleece. They can work very rapidly. An expert shearer can fleece up to 200 or more sheep in a day.

Sheep farmers hire expert sheep-shearers to attend to their flocks. In Australia and New Zealand, which together produce the bulk of the world's wool, most shearers work for a contractor, who is hired by a *grazier* (sheep rancher). Shearers work in teams or gangs, travelling to where the contractor sends them.

Shearing can take place at any time during the year. Shearing sessions are part of Australian tradition and often have a party atmosphere. In Australia and some other sheep-rearing countries, shearers take part in championship contests. A record for machine shearing was set in 1980 by John Fagan, who clipped 804 lambs in 9 hours at Hautora Road, Pio Pio, New Zealand. Another New Zealander, Peter Casserly of Christchurch, hand-sheared 353 lambs in 9 hours in 1976.

See also **Sheep**; **Wool**.

Shearing stress. See **Strength of materials**.

Shears. See **Scissors**.

Shearwater is the name of a group of sea birds that live in the oceans. They vary in length from 25 to 50 centimetres. Shearwaters are brown or greyish-black. Some species have white bellies. Shearwaters have slightly hooked bills, with tube-shaped nostrils. These birds soar over the waves, flapping their long, slender wings only

occasionally. Some fly alone, but others gather in flocks that may include thousands. They eat fish, squids, and small crustaceans.

Shearwaters come to shore only to reproduce, usually on an island. The female lays one large white egg in a hole dug in the ground, or in a concealed spot under rocks. Outside the breeding season, shearwaters undertake long migrations at sea. They do not visit land again until the next breeding season.

The *common shearwater* is about 35 centimetres long. There are several subspecies in both the Northern and Southern Hemisphere. The *short-tailed shearwater*, or *muttonbird*, breeds on islands in the Bass Strait between Australia and Tasmania. Large numbers of short-tailed shearwaters are killed each year for their meat and oil.

Scientific classification. Shearwaters belong to the family Procellariidae. The common shearwater is *Puffinus puffinus*, and the short-tailed shearwater is *P. tenuirostris*.

Sheeler, Charles (1883-1965), was an American painter and photographer. He was among the first American artists whose work shows the influence of cubism. Sheeler is best known for paintings that blend realism with the geometric forms associated with cubism. This style can best be seen in Sheeler's paintings of architectural forms, both interior and exterior.

Sheeler was born in Philadelphia, Pennsylvania. The style of his early paintings shows the influence of his art teacher, William Merritt Chase. Sheeler's paintings took on cubistic characteristics, especially after he exhibited in the Armory Show of 1913. In the late 1920's, Sheeler's work in industrial and architectural photography influenced his art. His paintings became precise and realistic while retaining the influence of cubism.

Sheen, Fulton John (1895-1979), became one of the best-known spokesmen for the teachings of the Roman Catholic Church in the world. His more than 50 books, along with his articles, brought Catholic doctrine to millions of people around the world.

In 1950, he resigned as professor at the Catholic University of America to direct the Society for the Propagation of the Faith in the United States. This is an international mission aid society which raises and distributes money for the support of Roman Catholic missionaries throughout the world. The year after his appointment to that post, he was named titular bishop of Cesariana. In 1966, he was named the bishop of the diocese of Rochester, New York, by Pope Paul VI. Sheen resigned from that position in 1969 and was named titular archbishop of Newport, Wales.

Sheen was a vigorous opponent of Communism in his writings and in his radio talks on "The Catholic Hour," a national programme begun in 1930. During the 1950's, he became widely known as a television personality for his "Life Is Worth Living" series.

Sheen was born in El Paso, Illinois, U.S.A. After his ordination in 1919, he studied philosophy at the Catholic University of Louvain in Belgium. In 1926, he began teaching at the Catholic University of America. That year Sheen also published his first book, *God and Intelligence in Modern Philosophy*. He also wrote *Communism and the Conscience of the West* (1948), *Peace of Soul* (1949), *Life Is Worth Living* (1953), and *The Priest Is Not His Own* (1963).



Cheviot and Leicester crossbreed

Sheep provide clothing and food for people. The warm, fleecy hair that covers the bodies of domestic sheep is made into comfortable wool cloth. Many people enjoy the strong taste of mutton or the milder taste of tender lamb. People in nearly every part of the world raise sheep.

Sheep are among the most important animals that people have tamed because they provide both food and clothing. Long before people began to write history, shepherds watched the flocks of sheep in the fields to guard them against attack by wild animals. Today, sheep are reared in all parts of the world. Australia is the world's leading sheep-producing country. In Australia, there are about 10 sheep for every person. In New Zealand, there are about 20 sheep for every person.

Sheep yield wool, meat, and leather. They also furnish the raw materials for many by-products, such as glue, tallow, suet, soap, fertilizer, cosmetics, and the catgut that is used in stringing tennis rackets.

The body of the sheep

Domestic sheep vary greatly in size. The *ewes* (females) of some breeds may weigh as little as 45 kilograms, while the ewes of some other breeds may weigh more than 100 kilograms. The *rams* (males) are larger. Their weight, including a heavy coat of wool, ranges from 70 to 160 kilograms.

Sheep are different from goats in many ways. They do not have the familiar beard of the billy goat, nor the well-known "goaty" odour. Sheep have a gland between their toes that is not found among the goats. The horns of a ram usually curve outward. In some breeds, both rams and ewes have horns. In other kinds, only the rams have horns, or the breed is hornless.

Sheep walk upon hoofs that are divided into two toes. The ankles of sheep are slim. However, the upper part of their legs is muscular, helping them to move quickly and easily.

Sheep have no incisor, or cutting, teeth on their upper jaws, though they have eight on their lower jaws. They have six grinding teeth on the back part of each jaw. Sheep can bite off grass much closer to the ground than cattle can. In fact, where too many sheep are allowed to graze, plant life may be severely damaged.

Most sheep have tails, but these are cut off for reasons of cleanliness.

Sheep live for an average of 7 years, but some live as long as 13. Most ewes give birth to one or two lambs at a time. The mother carries the lambs in her body for about five months before they are born. Ewes can begin breeding as early as six months of age, but most producers do not allow them to do so until they are about 1½ years old.

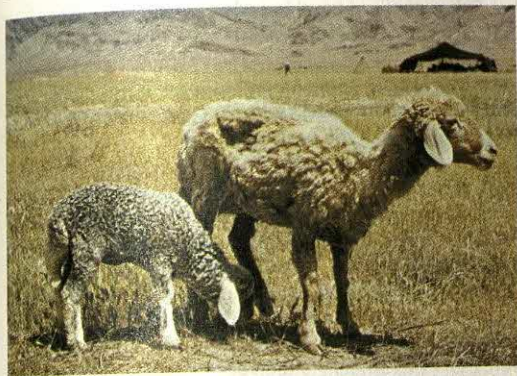
Wild sheep

Sheep are supposed to have come originally from the lofty plateaus and mountains of central Asia. The largest wild sheep, the *argali*, lives in the Altai Mountains of Siberia and Mongolia. The male argali stands 1 metre high at the shoulders. His spiral horns are 50 centimetres around.

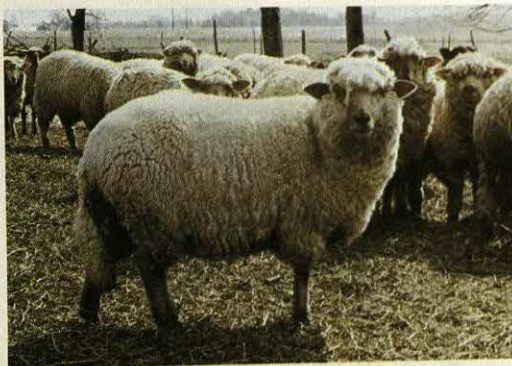
The great Marco Polo sheep of Asia live on the plateaus of Pamir, the "roof of the world," 5 kilometres above sea level. This sheep was first described by Marco Polo. The Marco Polo sheep is a little smaller than the argali, but it is remarkable for the wide spread of its horns. The *blue sheep*, or *bharal*, which is closely related to the goat, lives in Tibet. About half a dozen other kinds of wild sheep live in Asia.

Wild sheep look much like wild goats. Some kinds of wild sheep are thought to be halfway between sheep and goats. Wild sheep are high-spirited, daring, and self-reliant. They brave the fiercest storms of winter and climb higher than any other animals but mountain goats. Wild sheep live in bands among the mountains and plateaus of the Northern Hemisphere.

All the domestic breeds of sheep are descended from two different kinds of wild sheep. These are the *urial* of southern Asia, and the *mouflon*, which is the only wild sheep still living in southern Europe. Both kinds of wild sheep probably resemble their original ancestors. Many kinds of bighorn sheep live in North America.



Karakul



Suffolk and Corriedale crossbreed



Colbred



Romney

Breeds of domestic sheep

Domestic sheep have been slowly and carefully changed from their wild ancestors. Originally, the wild sheep were tamed for their hides and milk. They were also used to carry burdens. Very early, they became important for their fleece. The coarse hair that covered the wild sheep was replaced by a soft coat of wool through breeding. Only in the last 200 years have breeders developed the animals primarily for their meat.

Today, there are more than 800 breeds and varieties of domestic sheep throughout the world.

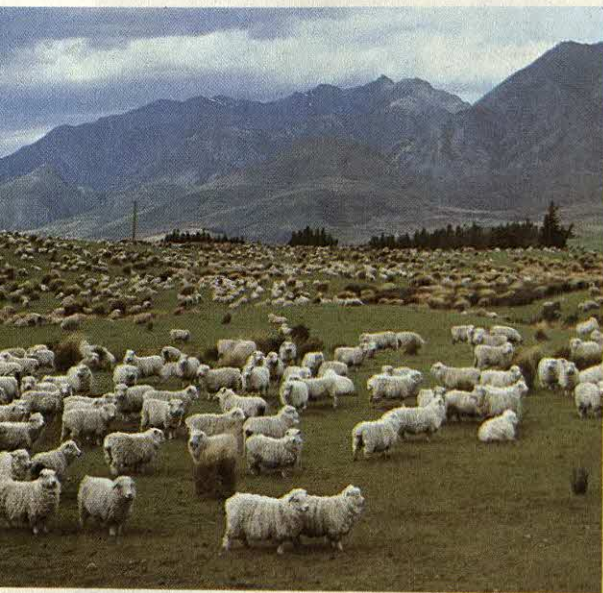
There are five main groups of sheep, depending on their fleece. They are *fine wool*, *long wool*, *crossbred wool*, *medium wool*, and *coarse wool*.

Fine-woolled sheep. Most fine-woolled sheep originated from the Spanish Merino breed. There are more sheep with Merino blood than any other breed. Spanish Merino sheep were developed in Spain. Their ancestors were probably brought to Spain by the ancient Romans. After the 700's, the Spanish Merino sheep became greatly prized. Until the late 1700's, the Spanish government forbade taking them out of the country, but many were smuggled into Germany and France. It was in these countries that the Merino was developed into the modern type of sheep.

The *Rambouillet* is another important breed that is descended from the Spanish Merino. It is named after a town in France, but it was largely developed in Ger-



Cheviot



New Zealand has about 20 times as many sheep as people. Southland, on South Island, is an important sheep-raising area.

many, and, later, in the United States. The breed began more than 150 years ago. This breed is very hardy.

Long-woolled sheep. Four of the most important long-woolled breeds are English breeds. They are the *Lincoln*, *Leicester*, *Cotswold*, and *Romney*. Lincoln sheep are among the largest of domestic sheep, and produce the longest fleece. The Leicester sheep is especially valuable to stock breeders for crossing with other sheep. It is the ancestor of most of the other long-woolled breeds of sheep. Romney sheep, which originated in southeastern England, are popular in New Zealand, and parts of the United States.

Crossbred-woolled sheep. Crossing two or more of the accepted domestic breeds to produce a new breed has become very common in developing modern types of sheep. Except for the Merino and Rambouillet types, probably all modern breeds are the result of such crossing. The *Corriedale*, a crossbred sheep, is popular throughout Australia, New Zealand, South America, and the United States. In the Corriedale, breeders attempted to combine the maximum wool and mutton production, to develop what is known as the dual-purpose sheep. The Corriedale was bred from fine-wool and long-wool sheep in Australia and New Zealand.

Medium-woolled sheep. These sheep are grown primarily for the meat they produce, but they also are a source of wool. The most important breeds are the *Hampshire*, *Shropshire*, *Southdown*, and *Suffolk*. Most farmers raise these sheep as purebreds. But in some countries, they are used for breeding with Merino ewes.

The face, ears, and legs of the Hampshire range in colour from dark brown to black. The black face, ears, and legs of the Suffolk contrast sharply with its white wool body. The Southdown is a rather small sheep with a square-shaped body. The *Dorset* sheep produces lambs earlier in the year than other breeds, and therefore is valuable for producing lambs for the winter mar-

ket. Other medium-wool breeds are the *Cheviot*, *No-Tail*, *Oxford*, *Tunis*, and *Ryeland*.

Coarse-woolled sheep. *Karakul* lambs have a glossy fur that is used in some countries to make fur coats. Lambs are usually killed and pelted when they are 3 to 10 days old, when the fur is most valuable. The *Scottish Blackface* produces a wool that is used for tweeds, carpets, and mattresses. American *Navajo* sheep also produce a coarse wool for rugs and blankets.

Other types. Some sheep are not classified within the five main groups. For example, *hair sheep* have coarse hair rather than wool. Most hair sheep, such as the *Djallonka* breed, are found in Africa.

Some sheep have been developed for milk production. *East Friesian* dairy sheep are raised in Germany. Milk from *Roquefort* sheep is used to make Roquefort cheese in France. Sheep's milk contains more protein than cow's milk and has a higher fat content.

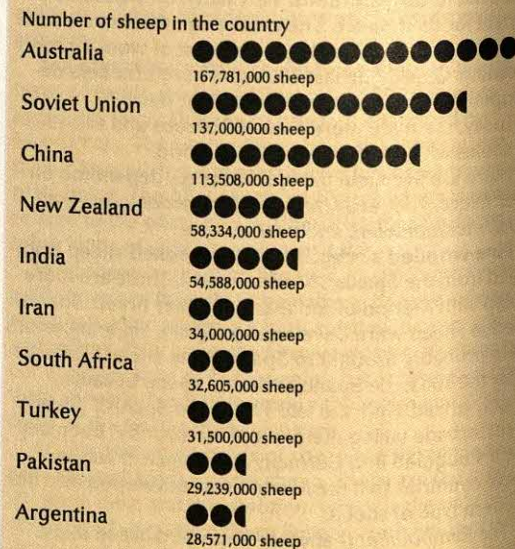
Raising sheep

There are two distinctly different ways of raising sheep. One way is on the range. Here, the animals are herded about in large flocks containing from 1,000 to 2,000 or more sheep. The sheep eat grass in the pasture.

The other way of raising sheep is on farms. The farmer raises from thirty to a few hundred head of sheep, keeping them in fenced pastures. During the winter, they are fed grain and hay grown on the farm.

Throughout history, sheep have generally been raised in places that are far from cities and other heavily populated areas. There are two main reasons for this. Compared with most products, wool is very valuable in proportion to its bulk. Furthermore, it does not spoil. Therefore, wool can be stored and shipped over long distances. In the second place, sheep tend to herd together, and therefore they can be handled in large flocks in open country with very little labour. Sheep can

Leading sheep-raising countries



Figures are for 1990, prior to the breakup of the Soviet Union.
Source: Food and Agriculture Organization of the United Nations.

live without water for long periods of time. Thus, farmers are able to rear sheep on dry plains.

Australia is the world's leading sheep-raising country. By far the most important sheep-raising state is New South Wales, which has almost one-third of Australia's sheep. Western Australia and Victoria are next in importance. Australia has three fairly distinct climatic zones where sheep are pastured. In the drier inland pastoral zone, cattle and sheep are grazed but no crops are grown. In the wheat-sheep zone, wheat farming and wool growing are combined. In the high rainfall zone, farmers combine raising sheep with mixed farming.

Enemies of sheep

Sheep are attacked by various parasites and diseases. Foot rot and sore mouth are common diseases. Sheep suffer from internal parasites, and also from a disease called *sheep scab* caused by mites and ticks. *Scrapie* is a virus disease of sheep caused by microscopic particles called *prions*. Scrapie closely resembles the cattle disease bovine spongiform encephalopathy. Meat-eating wild animals often attack sheep, and dogs sometimes kill sheep. The kea parrot of New Zealand sinks its sharp, hooked bill into the sheep's back, causing puncture wounds that can turn into open sores.

Scientific classification. Sheep belong to the bovid family, Bovidae. The urial sheep is *Ovis vignei*. The mouflon sheep is *O. musimon*. Domesticated sheep are *O. aries*.

Related articles in World Book include:

Animal (pictures: Animals of the mountains)	Foot-and-mouth disease	New Zealand (pictures)
Australia (Agriculture; pictures)	Karakul	Prion
Bighorn	Lamb	Ranching
Bovine spongiform encephalopathy	Lanolin	Ruminant
	Livestock	United Kingdom (picture)
	Mange	Wool
	Mutton	

Sheepdog is any of a number of breeds of dogs that people use to herd other animals. Sheepdogs return wandering animals to the herd and keep the herd together. Sheepdogs also defend the herd from attacks by wolves and other animals. In the past, the word sheepdog described dogs bred to herd only sheep. Today, the word is also used for dogs that herd other animals, including geese, ducks, cattle, and even reindeer.

Sheepdogs are loyal, gentle, and intelligent. They include such breeds as the *Australian cattle dog*, *Australian shepherd*, *Bearded collie*, *Belgian sheepdog*, *Cardigan Welsh corgi*, *Collie*, *German shepherd dog*, *Old English sheepdog*, *Pembroke Welsh corgi*, and *Shetland sheepdog*.

See also **Dog** (picture: Herding dogs).

Sheerness. See **Swale**.

Sheffield (pop. 500,500; met. area pop. 1,303,200) is an industrial city in north-central England. It lies in a scenic, hilly area where the River Don and River Sheaf meet (see **England** [political map]). An important manufacturing city, Sheffield has long been a centre for the production of high-grade steel, silver plate, and metal products. Its cutting tools and *cutlery*—silverware, teapots, and other table utensils—are internationally famous.

An Anglo-Saxon agricultural settlement probably stood on the site of what is now Sheffield as early as the A.D. 1000's. Sheffield grew rapidly during the Industrial Revolution of the 1700's and 1800's, when it became Eng-

land's main centre for steel production. Until the mid-1900's, the city had large run-down areas, and German bombs had destroyed sections of it during World War II (1939-1945). But a major urban-renewal programme, begun in the 1950's, wiped out most of this urban blight. Today, Sheffield has attractive public housing, modern commercial and industrial areas, and pleasant parks and other landscaped sites.

Sheik is an Arabic title referring either to an old and respected man or to the chief of a tribe or village. Sometimes a sheik is a religious leader. Only Muslims use the title of sheik. A sheik's power usually depends upon his own will and character. Songs and stories have pictured the sheik as a romantic figure.

Shekel is the monetary unit of Israel. The word *shekel* originally meant a unit of weight. The shekel was used as a weight by Babylonians, Phoenicians, and Hebrews. The Bible often refers to the Hebrew shekel. It weighed about 218 grains, or about 14 grams. It was first used as money in the form of uncoined gold and silver. The Hebrews coined their first shekels about A.D. 66. Half and quarter silver shekels also were coined.

Shekhar, Chandra (1927-), an Indian radical politician, served as prime minister of India from 1990 to 1991. He had been the president of the Janata Party from 1977 to 1988.

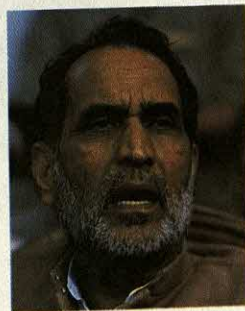
The son of a farmer, Shekhar was born in the village of Ibrahimpatti, in the state of Uttar Pradesh. After graduating with a master's degree in political science in 1951, he joined the socialist movement.

In 1965, he joined the Indian National Congress, and two years later was elected general secretary of the Congress Parliamentary Party. As a member of Parliament, he became a focal point of dissent within the Congress Party, always championing the underprivileged and opposing vested interests. In 1969, Shekhar founded *Young Indian*, a radical weekly publication that was frequently quoted. In 1975, when Prime Minister Indira Gandhi declared a state of emergency, Shekhar was arrested and imprisoned. He served as a member of Parliament from 1962 to 1984. He was elected to Parliament again in 1989.

Shelburne, Earl of (1737-1805), an Anglo-Irish nobleman, was prime minister of Britain in 1782 and 1783. He led the government that negotiated peace terms in 1782 to end the war between Britain and the United States. But Parliament voted against the peace terms, and Shelburne resigned. The Duke of Portland formed a coalition government that accepted the peace treaty.

William Fitzmaurice was born in Dublin. His family changed its name to Petty in 1751. He attended Oxford University and joined the army. He was president of the Board of Trade for a period in 1763 and secretary of state from 1766 to 1768. He became Earl of Shelburne in 1764, and Marquis of Lansdowne in 1784.

Shell is a projectile. See **Ammunition**.



Chandra Shekhar



Coiled shell of land snail



Brittle bird's egg shells



Leathery shell of sea turtle



Huge shell of giant clam with crown-of-thorns starfish



Tough shell of stag beetle



Plated shell of armadillo

Shell

Shell. Many kinds of animals and plants have shells. Lobsters, mussels, oysters, shrimps, snails, and turtles all grow shells. Shells also hold the seeds and nuts of the coconut, peach, walnut, and other plants.

Most shells grow on the outside of an animal or plant. These shells are like strong suits of armour that protect the bodies they cover. Some shells grow inside the bodies of cuttlefish and many kinds of squids. These shells, called *cuttlebones* in cuttlefish or *pens* in squids, help support the bodies of the animals.

Some kinds of shells have beautiful shapes and bright colours. Others are plain and colourless. Among the smallest kinds are the shells of vitrinellids, marine snails found in many parts of the world. Some vitrinellid shells grow only about as big as a grain of sand. The largest shell is that of the giant clam, which lives in the South Pacific and Indian oceans. The shell of the giant clam may measure more than 1 metre long and weigh 230 kilograms.

Some kinds of animals begin their lives inside egg shells. Thin, brittle shells cover the eggs of birds. Thick,

leathery shells protect the eggs of crocodiles, snakes, and many other reptiles. Strong, rubbery shells hold the eggs of the platypus and echidna.

Many other animals spend all their lives in shells that are important parts of their bodies. The shells of clams and oysters are really the skeletons of these animals. The shells of turtles and tortoises include part of their backbone and ribs.

Many people collect shells as a hobby. Most shells in these collections belong to *molluscs*, a group of animals that includes clams, conchs, cowries, oysters, and snails. This article provides general information about mollusc shells. It discusses how shells are formed, kinds of mollusc shells, collecting shells and conservation, and uses of shells.

For information about the animals that grow these shells, see the separate *World Book* article on *Mollusc* and its list of Related articles. For information about other kinds of shells, see the *World Book* articles on *Egg and Seed*, and articles on individual plants and animals, such as *Walnut* and *Turtle*.

There are about 100,000 *species* (kinds) of molluscs. Each kind has a shell with its own special design and shape, but all are formed in much the same way. Some molluscs that grow shells live in the ocean, some in fresh water, and others on land.

Most shells consist of three layers—an outer, middle, and inner layer. These layers are also called the *prismatic layer* (outer layer), the *lamellar layer* (middle layer), and the *nacreous layer* (inner layer). Each layer contains a form of calcium carbonate, a kind of lime also found in marble and some other kinds of rocks. In most shells, the mineral in these layers makes the shell hard. In the outer layer, the mineral may be in the form of small particles called *prisms*. In the inner layer, the mineral is often produced as a smooth, shiny substance called *nacre* or *mother-of-pearl*. The nacre of certain kinds of shells, including those of cockles and scallops, has a dull appearance.

The food eaten by a mollusc contains the minerals that form the shell and give it colour. The blood stream of the animal carries the minerals to the *mantle*, a fleshy

skinlike tissue inside the shell. Special glands in the mantle produce the liquid substances that make the shell. Other glands in the mantle add a hardening material so that the liquid quickly becomes firm and strong. Still other glands produce the colour. The pattern of the colour depends on (1) whether colour is added continuously, and (2) the number of places in the mantle from which colour is added. For example, if colour is added continuously from only one place in the mantle, the shell will have one stripe. If colour is added continuously from four places, the shell will have four stripes. If the colour flow is interrupted from time to time, spots or bars will form on the shell.

Most kinds of molluscs add material to their shells throughout their lives. As long as the animal grows, its shell also grows. Clams and snails begin to grow shells before they hatch. After they leave the egg, their bodies rapidly increase in size. A sea snail that is only 3 millimetres long when it hatches may grow 13 or 15 centimetres in six months. Most clams and sea snails grow for about six years.

Kinds of mollusc shells

Mollusc shells can be divided into five main groups, each with a common name and a scientific name. These groups are (1) univalves or Gastropoda, (2) bivalves or Bivalvia or Pelecypoda, (3) tooth shells or Scaphopoda, (4) octopuses and squids or Cephalopoda, and (5) chitons or Polyplacophora. A sixth group, the Monoplacophora, is rarely seen. Scientists have found these shells only as fossils or in the deepest waters of the Indian and Pacific oceans.

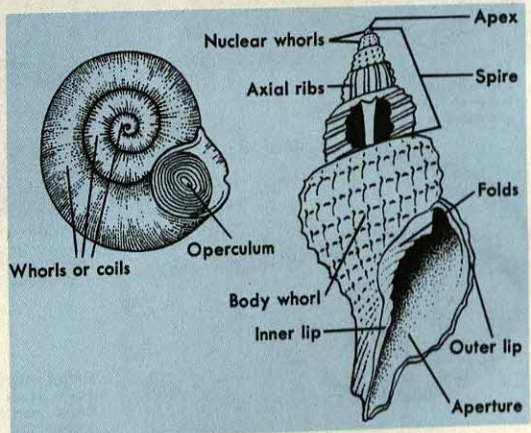
Univalves. The word *univalve* means *one shell*. Snail shells are univalves. Most snails have a tubelike shell that winds around itself as it grows. The soft body of the snail is in the open part of the tube. Most snail shells grow by winding to the right in a clockwise direction when viewed from above, and are called *right-handed shells*. A few kinds of snails have *left-handed shells*.

The shells of univalves have an opening at one end. Most of them have a hard lidlike part called an *operculum* at the opening. The animal can pull the operculum over the entrance of the shell to keep out such enemies as fish and crabs.

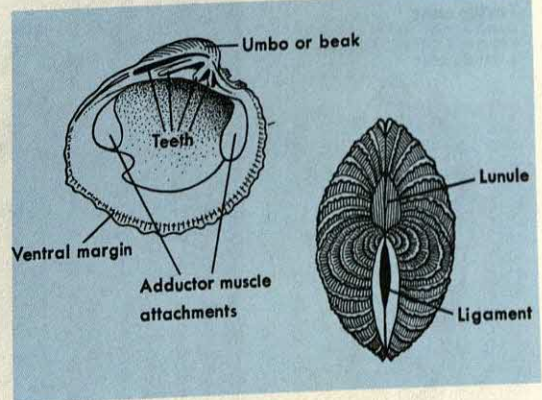
Univalves are found in almost every part of the world except on the highest mountain peaks. Some live in the ocean, some in fresh water, and some on land. Many ocean univalves have smooth, glossy shells. Others have shells with deep ridges, rough surfaces, and long, sharp spines. The carrier shell snail attaches bits of shells, stones, and other objects to its soft shell substance as it grows. The shell substance acts as cement, and when the shell hardens, the objects are held firmly in place. Most types that live in fresh water or on land have thin, smooth shells. Many tree snails, particularly those of the tropics, have brightly coloured shells.

Limpet shells are also univalves. These shells grow almost flat and form a point in the centre. The shells of keyhole limpets have a hole at the top, and look like miniature volcanoes.

The parts of a univalve shell



The parts of a bivalve shell



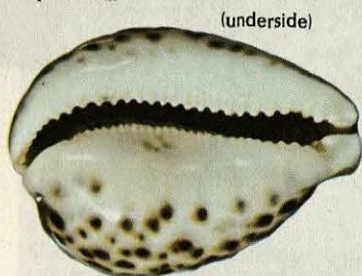
Univalve shells



Commercial top shell
Trochus niloticus
Indian and S.W. Pacific oceans
1/2 actual size



Tiger cowrie
Cypraea tigris
Indian and S.W. Pacific oceans
1/2 actual size



(underside)

Textile cone
Conus textile
Indian and S.W. Pacific oceans
1/2 actual size



Delphinula shell
Angaria delphinus
S.W. Pacific Ocean
Actual size



Carrier shell
Xenophora neozelanica
New Zealand Coast
1/2 actual size



Tent olive shell
Oliva porphyria
Pacific Coast of Panama
1/2 actual size

Regal murex
Murex regius
Pacific Coast, Mexico to Panama
1/2 actual size



Oriente tree snail
Polymita picta
Cuba
Actual size



Eastern moon snail
Polinices duplicatus
U.S. Atlantic Coast
1/2 actual size



Limpet
Patella lugubris
Azores
1/2 actual size

Left-handed whelk
Busycon contrarium
U.S. Atlantic Coast
1/2 actual size



Crown conch
Melongena corona
West Florida Coast
Actual size



Bivalve shells



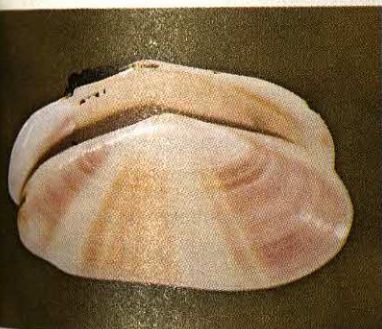
Fragile river mussel
Leptodea fragilis
U.S. inland waters
½ actual size



Pacific thorny oyster
Spondylus pictorum
Pacific Coast of Mexico
½ actual size



Mantle scallop
Gloripallium pallium
S.W. Pacific Ocean
½ actual size



Sunrise tellin
Tellina radiata
West Indies
½ actual size



Mussel
Mytilus edulis
North Atlantic Ocean
½ actual size



Royal comb Venus
Pitar dione
Caribbean Sea
½ actual size

Nautilus shell



(whole)

Chambered nautilus
Nautilus pompilius
S.W. Pacific Ocean
½ actual size

(cutaway)



Chiton shell

West Indian chiton
Chiton tuberculata
West Indies
½ actual size



Tooth shell

Elephant's tusk shell
Dentalium elephantinum
Japan and Philippine Islands
Actual size



There are over 60,000 species of univalve shells. The largest are the horse conch of the Caribbean and the baler of Australia. Both grow over 60 centimetres long. A giant African snail has a larger shell than any other land snail. It is about 20 centimetres long. Many univalves have shells so small they can hardly be seen with the unaided eye. A row of 30 *Barleeia* snail shells is less than 2.5 centimetres long.

Bivalves have two matching shells. The shells move on hinges that look like small teeth. Clams, cockles, mussels, oysters, razorshells, and scallops are bivalves. Bivalves keep their shells open when resting and undisturbed. A broad band of elastic tissue acts like a prop to hold the shells apart. Bivalves also have one or two strong *adductor* muscles attached to both shells. If an enemy comes near, these muscles snap the shells shut and keep them closed. If the muscles get tired or relax, the shells open again. An enemy usually does not wait this long.

Bivalves are found almost everywhere except on dry land. There are about 11,000 kinds of bivalves. Most of them live in shallow ocean waters near land and in lakes, but a few species live in the beds of large rivers. Common bivalve molluscs are among many that are harvested for food. They include clams, cockles, mussels, and oysters.

The giant clam of the South Pacific, whose shell can grow 1 metre long, is the largest bivalve. The smallest include turton clams of the North Atlantic. They grow about half as large as a grain of rice.

Tooth shells look like long needles or like miniature elephant tusks. They are sometimes called *tusk shells*. The shells are hollow tubes that curve slightly and become smaller at one end. Both ends of the tooth shell are open.

Tooth shells are found in the sand or mud of the ocean bottom in many parts of the world. Some kinds live close to shore. Others burrow in the ocean floor far below the surface of the water. The small end of the shell sticks up into the water.

Scientists recognize about 500 kinds of tooth shells.

The shells vary from 1 to 15 centimetres. Most are white, but some have green, red, or yellow tints. The most colourful kind is an elephant's tusk from the Philippines. It is dark green with bluish ribs.

Octopuses and squids. In this group of marine animals, the cuttlefish and squids have shells inside their bodies. The cuttlefish, also called the *Sepia* squid, has a chalky cuttlebone inside its body. This shell is light and spongy, but it serves as a strong support for the animal's body. The *Spirula* squid has a shell about 2.5 centimetres long under the skin at the rear of its body. The coiled *Spirula* shell looks somewhat like a ram's horn. In tropical countries, waves often wash these coiled shells ashore. Octopuses have no shells.

Perhaps the best-known shell of this group is the chambered nautilus, also called the pearly nautilus. It consists of a series of chambers, each larger than the one before. Thin walls seal off every chamber except the outer one, where the soft body of the nautilus is found. The coiled shell is cream coloured with brown stripes, and the chambers are lined with shiny mother-of-pearl. Nautilus shells grow up to 25 centimetres in diameter. They live mostly in the western Pacific.

The paper nautilus or argonaut has a single, paper-thin shell much like that of the chambered nautilus, but with no chambers. The paper nautilus never lives in its shell, which serves only as an egg case. The female builds the thin, fragile shell, and carries it about until the eggs hatch. Then she lets it float away. The paper nautilus lives at the surface of warm tropical seas.

Chitons. A chiton shell consists of eight separate, movable pieces called *plates* that are held together by a surrounding leathery *girdle* (belt). The girdle acts like a series of hinges between the plates and allows the animal to bend and move about easily. Chiton shells are also called coat-of-mail shells because they look like tiny suits of armour. Chitons attach themselves to rocks in the sea. Some species of chitons are less than 2.5 centimetres long. The largest chiton, Steller's chiton of the Pacific coast of North America, grows up to about 30 centimetres long.

Collecting shells, and conservation

Collecting shells has been a popular hobby since the mid-1800's and has increased enormously in recent years. Shells are now sold all over the world in souvenir shops, department stores, and beach stalls. However, the collection of large numbers of molluscs for their shells can significantly reduce their numbers and may even lead to the threat of extinction.

Most early collectors had little impact on mollusc populations. But with the commercialization of the hobby, problems have arisen. Enormous numbers of the larger, more colourful varieties of shells are now collected for sale as marine curios. Furthermore, shells are only valued if they keep their glossy original coloration and are not broken or cracked. Therefore, they are collected when the animal is still alive, because once a mollusc dies its shell quickly becomes damaged in the waves and currents.

Most shells on sale in gift shops, and of interest to collectors, are from tropical seas, mainly from coral reefs. These shells appeal to the general public and collectors because they tend to have particularly attractive patterning, coloration, and shapes. Each year, more than 2,000 metric tons of ornamental shells are exported from the Philippines. Other major suppliers include Mexico, India, and numerous countries in the Caribbean, and the Indian and Pacific oceans. The shells of temperate species in rock pools and on intertidal shores are often easier to find. But these shells are not often sold as marine curios.

Over-collection of the more popular species has been reported from Australia, the Philippines, Kenya, the Seychelles, and Florida, U.S.A. Giant clams have almost become extinct in Fiji and parts of the Philippines. Giant clams are also collected for their meat, which is consid-

ered a delicacy in Asia. The beautiful giant triton, traditionally used by Pacific islanders as a trumpet, is now very rare.

Shells from some land snails are also very popular with collectors. Many tropical land snails, such as the Manus green tree snail and the Hawaiian tree snails, have brilliantly coloured and patterned shells. However, they often only occur in very small areas. The Manus green tree snail is found only on Manus Island, in Papua New Guinea. Some of the Hawaiian tree snails are also restricted to single islands, and in some cases to single valleys. Over-collecting of these species can seriously reduce their numbers. Hundreds of thousands of Hawaiian tree snails were collected at the end of the 1800's. On one island, 22 species of native tree snails are now extinct and a further 19 are endangered, although collecting is now prohibited.

Marine molluscs are fortunately not so endangered, but many countries are now taking action to prevent further commercialization of shell collecting. In some countries, such as Australia, Mauritius, and the Seychelles, shells may only be collected under licence, and collecting of rare species is prohibited. In many Pacific

countries, it would be difficult to ban collecting altogether, because mother-of-pearl exports are an important part of the economy. As a result, regulations have been introduced to restrict collection to shells of a certain size.

With proper care and management, shells can be a valuable resource to humans. The shellcraft and mother-of-pearl industries provide much-needed income for poor people in tropical countries. Imports of shellcraft into the United States, the main consumer country, increased during the 1970's and 1980's. But if the shells disappear, the livelihoods of the people who gather them would be threatened. Countries are being encouraged to set up management programmes for these industries. These programmes carefully monitor the number of shells being taken and the impact of collecting on population.

Molluscs can also be "farmed," which reduces the pressure on wild populations. For example, giant clams from the Pacific and queen conches from the Caribbean are being reared in tanks on land. When the young shells are large enough, they are put back into a protected area of the sea, and left to grow to full size.



The Manus green tree snail is a rare snail sought by collectors. It is found only on Manus Island, Papua New Guinea.



Shell shops in tropical coastal areas sell a variety of shells, among them conch shells.



Clam shells are sold as soap holders, left, in Brisbane, Australia. Hanging lampshades made from hundreds of small shells, right, are popular items for sale in Southeast Asia.

Uses of shells

The colour and lustre of shells make them especially useful as decorations and for jewellery. Manufacturers cut the shells of freshwater mussels and other mother-of-pearl shells to make pearl buttons. Craftworkers use mother-of-pearl from abalone and oyster shells to decorate fancy boxes, jewellery, and musical instruments. Artists carve raised designs called *cameos* in many kinds of shells to make jewellery. Conches and some other large shells can be polished and used as lamp bases or paperweights. Craftworkers fasten many kinds of small shells together in the shape of animals or dolls, or to form attractive designs.

Scientists sometimes use shells to help them in their work. Atomic scientists may expose shells to atomic rays to test the effects of radiation. Oil prospectors search for certain kinds of fossil shells in deserts and prairies. The shells show that the area was an ocean bed in ancient times. Large oil pools formed in many of these ancient ocean beds.

In prehistoric times, cowrie shells and tooth shells were used as money. The Phoenicians and Romans made a purple dye from *Murex* sea snails. They believed that cloth coloured with this dye was more valuable than gold.

The Indians of North and South America also used shells as money. North American Indians carved wampum beads from large clam shells and parts of the knobbed whelk of the Atlantic Coast.

In the Philippines, the thin, almost transparent shells of the *Placuna* oyster serve as window "glass." The shells are cut into small squares and put into narrow wooden frames. The frames are then fastened together to make a large window. Lampshades, boxes, trays, bowls, and many other objects are now made from these shells.

Study aids

Related articles. See *Mollusc* and its list of *Related articles*.

See also the following articles:

Armadillo	Nummulite
Button	Pearl
Crustacean	Turtle
Fossil	Wampum
Mother-of-pearl	

Outline

- I. How shells are formed
- II. Kinds of mollusc shells
 - A. Univalves
 - B. Bivalves
 - C. Tooth shells
 - D. Octopuses and squids
 - E. Chitons
- III. Collecting shells, and conservation
- IV. Uses of shells

Questions

- What is a univalve shell?
- What is the largest shell?
- How many layers do most mollusc shells have?
- What is *conchology*?
- When do clams and snails begin to grow shells?
- Where do molluscs get the minerals for their shells?
- What do keyhole limpet shells look like?
- Why are tooth shells sometimes called *tusk shells*?
- How does the paper nautilus use its shell?



"Madonna of the Sea"

Shell mosaic, by Edward Waldo Forbes and associates, is made from pieces of clam shells fitted to form the design.



The Metropolitan Museum of Art

A golden shell, above, forms the top of an elegantly designed jewelled cup known as the Rospigliosi Cup.

A butterfly pin, below, combines gleaming mother-of-pearl with silver to make the insect's colourful wings.



Shellac is the liquid formed of resin flakes which have been dissolved in alcohol. It is used as a varnish. The flakes are the dried form of a sticky substance called *lac resin* (see *Lac*). When shellac is applied to a surface, the alcohol in the solution evaporates, leaving a shiny finish. Shellac resin flakes are yellow, orange, or reddish, but can be bleached white. Shellac is also used in the manufacture of sweets, medicine, printing inks, in insulating materials, and as a stiffener.

See also **Lacquer**; **Resin**; **Varnish**.

Shelley, Mary Wollstonecraft (1797-1851), was an English author. Shelley wrote the most famous of all Gothic horror novels, *Frankenstein* (1818).

Shelley was born in London. Her family name was Godwin. Her father was the philosopher William Godwin, and her mother was Mary Wollstonecraft, an early feminist. When she was 16, she met the poet Percy Bysshe Shelley. Although Shelley was married, Mary ran away with him. They were married after Shelley's first wife died in 1816. In 1818, while the Shelleys were visiting the poet Lord Byron in Geneva, Mary conceived the idea for *Frankenstein*.

Shelley drowned near Leghorn, Italy, in 1822. To support herself and her children, Mary wrote novels, including *Valperga* (1823), *The Last Man* (1826), and the autobiographical *Lodore* (1835). She also edited her husband's poetry.

See also **Frankenstein**; **Gothic novel**; **Shelley, Percy Bysshe**; **Godwin, William**; **Wollstonecraft, Mary**.

Shelley, Percy Bysshe (1792-1822) was one of the great English lyric poets. He experimented with many literary styles and had a lasting influence on many later writers, particularly Robert Browning, Algernon Charles Swinburne, William Butler Yeats, George Bernard Shaw, and Thomas Hardy.

His life. Shelley was born on Aug. 4, 1792, in Sussex into a wealthy and politically prominent family. He had a stormy career at Eton College and Oxford University, from which he was expelled in 1811 for writing a pamphlet called *The Necessity of Atheism*.

In August 1811, Shelley eloped with 16-year-old Harriet Westbrook, the daughter of a former coffeehouse owner. He abandoned her in 1814 and ran away with Mary Wollstonecraft Godwin. Although both said they did not believe in marriage, Shelley and Mary Godwin were married in 1816, after Harriet drowned herself. See **Shelley, Mary Wollstonecraft**.

Shelley believed the Irish were being oppressed by their English rulers, and tried to rouse the Irish to rebel against England. He wrote *Queen Mab* (1812-1813), a revolutionary poem which attacked both political tyranny and orthodox Christianity.

In 1816, Shelley and his wife formed a close friendship with the poet Lord Byron in Geneva, Switzerland. After March 1818, Shelley went into permanent exile in Italy. There he wrote a sequence of important poems, including *Prometheus Unbound* (1820), *The Witch of Atlas* (1820), *Epipsychidion* (1821), and *Hellas* (1821). The death of an acquaintance, the English poet John Keats, inspired Shelley's elegy *Adonais* (1821). On July 8, 1822, Shelley drowned during a storm while sailing near Leghorn, Italy.

His writings. Shelley's poems are emotionally direct, but difficult to understand intellectually. Much of his po-

etry is autobiographical, including his most famous lyric "Ode to the West Wind" (1819). Shelley's spiritual attitudes were intensely personal and tended to oppose traditional Christian views. Shelley felt that spiritual truth was not based on either supernatural revelation or natural experience. Instead, he thought truth could be understood by the imagination alone. The role of the imagination as a spiritual guide is the subject of "Mont Blanc" (1816). This powerful meditative poem first revealed Shelley's mature style.

In his most ambitious long poem, the lyrical drama *Prometheus Unbound*, Shelley attempted to combine his imaginative faith with his hopes for humanity. Like much of Shelley's work, this play is based on classical Greek models. Prometheus, the creative power in humanity, is liberated by Demogorgon, a mythical figure who stands for inevitable change in human events. At the end of the play, earthly rulers and government institutions are defeated and love and beauty reign, but perhaps not forever.

Shelley's poetry became sombre after the revolutionary hope expressed in *Prometheus Unbound*. The Irish poet William Butler Yeats described Shelley's themes as an increasing conflict between infinite desire and the inability fully to realize such desire. *Epipsychidion* expresses Shelley's love for an Italian noblewoman, Emilia Viviani. This poem tries to achieve a vision of ideal love finding its lasting home in an earthly paradise. The poem ends in despair of its own quest.

In 1821, Shelley wrote his famous essay *A Defence of Poetry*. The work is valuable for its insights into every poet's general ideas and Shelley's views on the role of imagination in poetry.

Whether Shelley had begun to find some definite faith, philosophical or otherwise, we do not know, but his final poems are as grim and sorrowful as any he wrote. The last love lyrics that Shelley wrote are serene only in their hopelessness. According to his powerful unfinished poem on human defeat, *The Triumph of Life*, good and the means of accomplishing good cannot be reconciled. However grim his final vision, Shelley always looks toward the hope of inspiration, as in the "Ode to the West Wind":

Scatter, as from an unextinguished hearth
Ashes and sparks, my words among mankind!
Be through my lips to unawakened earth
The trumpet of a prophecy!

Shellfish. See **Crustacean**; **Mollusc**.

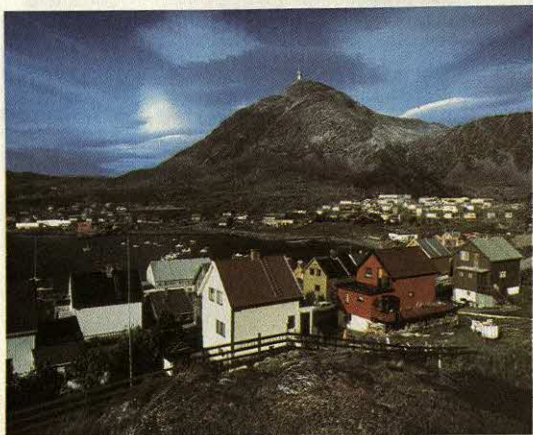
Shelter is a structure or a natural feature that provides protection against bad weather, danger, or insect pests. People need shelters to shield them from extremes of cold and heat, as well as from rain, snow, and wind.

There are many kinds of shelters. Houses are the most common form. Other kinds of shelters are bus shelters, bomb shelters, sheds, and bandstands. Portable shelters



Portrait by Amelia Curran;
National Portrait Gallery, London

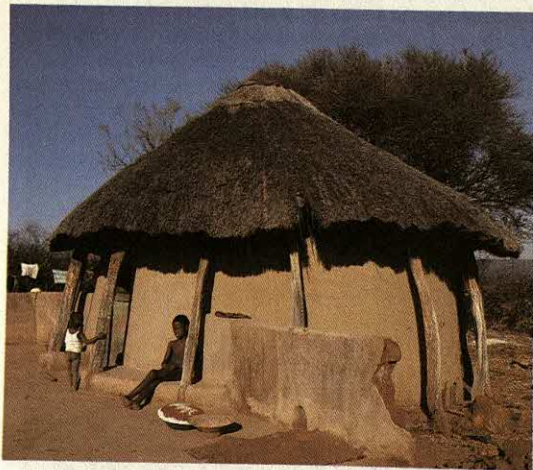
Percy Bysshe Shelley



Houses in Norway have steep, pointed roofs that allow snow to slide off easily during the winter. The roofs also must be strong enough to bear the weight of heavy snow.



Oriental houseboats provide shelter for many families. Many people live in boats for a lifetime, cooking their meals, eating them, and sleeping in the same small quarters.



Village houses in many dry areas of Africa are built of mud. This mud house is in Botswana, in southern Africa.

include tents, trailers, and such boats as houseboats and motor yachts.

The first shelters made by human beings were built of animal hides, stones, straw, vines, or wood. Today, people construct shelters from a wide variety of materials. Many home builders use wood and brick. Steel and concrete provide the framework for high-rise flats. Builders also use such materials as aluminium, glass, and plastic.

This article deals with human shelter. Animals also build shelters, such as birds' nests and rabbit burrows. For information on animal shelters, see *Animal* (Animal homes).

Why shelters differ around the world

People build many different kinds of shelter throughout the world. The types of shelters they erect depend chiefly on the climate and on what building materials are available.

Climate. In hot areas, such as the southern and southwestern United States, the weather is warm enough for people to live outside much of the time. But they still need protection from sun, rain, and insects. Houses in such areas have many screened windows, doors, and other openings that let in breezes but keep out insect pests.

In parts of Northern Europe, Canada, and other cool regions, houses are designed to keep out the cold and keep in heat. Buildings may have thick walls and storm windows to minimize heat loss.

In such northern cities as Toronto and Calgary, Canada, heated walkways connect flats to offices, shopping malls, theatres, and other facilities. Residents of these flats may go about their everyday activities during the winter months without going outside.

In such snowy countries as Norway and Sweden, people build houses with sloping roofs so that snow will slide off easily. They also make the roofs strong enough to hold the weight of heavy snow.

Building methods and materials vary widely throughout the world. In regions with large forests, many people use wood to build homes. Timber is easy to build with, but most wooden buildings are less sturdy than those made of stone or concrete. Builders almost anywhere can use concrete or bricks.

In areas with little rainfall, people build shelters of clay or mud. In Mexico, for example, people mix clay and dirt or mud with water to make adobe. Some people in India and other countries live in clay shelters. In dry areas of Africa, people make mud houses.

In wet tropical areas, moisture causes wood shelters to rot within a few years. People in these areas build houses from other materials. For example, in some parts of Africa and on many Pacific islands, people weave the stems of tall grass into houses.

High-rise buildings made of steel and concrete are most common in such industrial countries as the United Kingdom and the United States. However, nearly every country has some steel and concrete structures. *Prefabricated buildings* consist of parts manufactured at a factory and then shipped to the construction site. There construction workers assemble the parts. Many prefabricated shelters use large amounts of plastic and other lightweight materials.

Other reasons. Tradition influences the type of shelters people build. Homes in Latin America, for example, show the influence of the early Portuguese and Spanish settlers. Many dwellings are constructed of adobe and have tiled roofs.

Special hazards also influence the shelters people build. In Japan, a country where earthquakes occur frequently, people make their homes of lightweight materials. Such homes are safer than structures of stone or other heavy materials if an earthquake topples them. In Indonesia, the Philippines, and other countries with much swampland, people erect houses on stilts to protect them from the water.

Shelter through the ages

Prehistoric times. Some early human beings lived in caves. They used stone tools to deepen the caves and smooth the walls. Other early people built dwellings from animal skins, stones, and clay bricks. Some houses stood on tall stilts for protection against animals. People who lived near lakes or rivers built such dwellings over water. They drove the stilts into the lake or river bottoms near the shore.

Ancient times. The rise of civilization led to the construction of better and larger buildings. Instead of simple shelters, people worked to build stronger defensive walls, more impressive palaces, and finer temples to honour their gods. These efforts brought a new art—architecture—into being. But the basic function of architecture was still to provide shelter. For example, the gigantic pyramids of ancient Egypt served not only as monuments to dead rulers but also as shelters for their remains. Ordinary Egyptians built flat-roofed homes of mud or sun-dried bricks. Wealthy Egyptians built spacious homes of brick and wood.

The ancient Greeks built houses around courtyards.



A house in the Midwestern United States—where summers are warm—includes a porch with screens on the windows and door. The screens let in breezes and help keep out insects.

The Greeks also designed many temples and other public buildings.

Wealthy people in ancient Rome lived in large houses built of concrete and brick or stone. Some Roman houses included a central heating system and plumbing. The Romans also were the first people to use glass windowpanes. In addition to houses, the Romans constructed many large public shelters, including baths, temples, and theatres.

The Middle Ages lasted from about the A.D. 400's to the 1500's. During this period, architects designed magnificent cathedrals, such as those at Chartres, France, and Durham, England. Such buildings provided more than a roof over worshippers. Medieval Christians believed that, in a symbolic sense, God and the saints inhabited churches. As a result, they regarded cathedrals and other church buildings as shelters for holy beings.

By the 1000's, European rulers lived in castles with thick stone walls, water-filled moats, and drawbridges. In about the 1400's, Europeans began to build *half-timbered houses*. These structures had frameworks of timber, filled in with brick or interwoven branches plastered with mud or clay. Many had a thatched roof.

The Renaissance, a period of European history that lasted from about 1400 to 1600, revived interest in the art and learning of ancient times. As a result, architects studied ancient Greek and Roman buildings and modelled their designs on those classical styles. Monarchs and other wealthy Europeans hired architects to design



High-rise apartment buildings are common in heavily populated areas, where land is scarce and expensive. These high-rise buildings are in a residential area of Chicago.

palaces inspired by Roman structures. Classical styles also influenced the houses of middle-class people during the Renaissance.

The Industrial Revolution, a period of rapid industrial growth and new inventions, began in Europe during the 1700's. It brought the development of many new building materials and construction methods. People began to build tall structures with steel or iron frames. Concrete also became a common construction material.

The Industrial Revolution also led to the construction of new types of shelters. For centuries, builders had concentrated on homes and such public buildings as churches and palaces. The Industrial Revolution required such new structures as factories and exhibition halls. For example, the Great Exhibition of 1851, an industrial fair held in England, was housed in a glass and iron structure called the *Crystal Palace*. The building, which resembled a huge greenhouse, was the first important structure to have prefabricated parts. As a result of the Industrial Revolution, modern builders can choose from a wide range of construction methods, building materials, and styles.

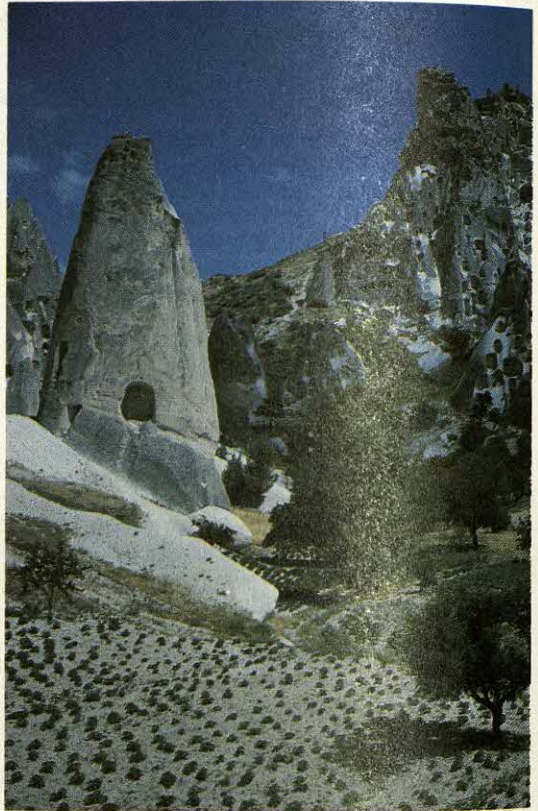
Related articles in *World Book*. See *House and Housing*. See also the following articles:

Kinds of shelter

Castle	Mobile home
Houseboat	Tent
Igloo	Tepee
Lake dwelling	Wigwam
Log cabin	

Other related articles

Architecture	Eskimo (Shelter)
Building construction	Housing
Cave dwellers	Indian, American (Shelter)
Climate (Housing and climate)	Indonesia (Shelter)



Ancient "skyscrapers" still provide shelter for Turkish farmers. Early Christians hacked out the rooms in volcanic cones.

Shenyang (pop. 4,130,000), also called Mukden, is the capital of Liaoning Province in China. It lies in Manchuria, on the bank of the Hun River. Five railways meet at Shenyang. The city is in the centre of the most thickly populated part of Manchuria. It has three airports. Factories in Shenyang produce metal products, machine tools, and aeroplanes.

The centre and oldest part of Shenyang was built during the Middle Ages. It has narrow streets and ancient buildings, and is surrounded by high stone walls. Outside this section lies the Russian quarter, which the Russians built in the early 1900's, when they occupied Shenyang. The Japanese developed many suburbs of factories and homes when they invaded Manchuria in 1931. North of Shenyang is a beautiful park which contains the tombs of the Manchu emperors who once ruled the vast Chinese Empire.

A major battle of the Russo-Japanese War (1904-1905) took place in Shenyang. The Japanese invasion of Manchuria (1931) began with a clash between Japanese and Chinese forces near the city.

She-oaks include 70 species of shrubs and trees of the Western Pacific region, especially Australia. They range from dwarf shrubs, just a metre tall, to majestic *river oaks*, up to 30 metres tall. Early settlers used she-oak wood for roof shingles. The she-oak is not related to the European oak, but the wood of the two trees is similar. She-oaks are used for hedging and for windbreaks. They



A house on stilts stands by a river in a swampy area of Papua New Guinea, *above*. Such shelters are elevated to provide protection from moisture on the ground and from floods.

are also tolerant of salt water and can be planted at the coast.

Scientific classification. She-oaks belong to the family Casuarinaceae and the genus *Casuarina*.

Shepard, Alan Bartlett, Jr. (1923-), became the first American in space. On May 5, 1961, astronaut Shepard rocketed 188 kilometres into space from Cape Canaveral, Florida. He landed 15 minutes later, 486 kilometres out in the Atlantic Ocean. In 1971, Shepard commanded Apollo 14, the third landing on the moon. He became the fifth astronaut on the moon. He had been grounded from 1963 to 1969 because of an ear disorder.

During his first flight, Shepard lay on a padded fibre-glass contour couch inside a capsule mounted on a Redstone rocket. The capsule, named *Freedom 7*, weighed more than 900 kilograms. Shepard made his historic flight less than a month after Major Yuri Gagarin of the Soviet Union had orbited the earth in the world's first manned space trip. Unlike Gagarin's spacecraft, Shepard's ship could be manually controlled during the flight. *Freedom 7* reached a top speed of 8,336 kilometres per hour and endured forces 12 times the force of gravity while reentering the earth's atmosphere.

Shepard was born in East Derry, New Hampshire, U.S.A. He graduated from the United States Naval Academy in 1944. After serving on a destroyer during World War II (1939-1945), he took flight training and became a Navy test pilot. In 1959, Shepard was chosen to be one of the first U.S. astronauts. He received the Distinguished Flying Cross and the Distinguished Service Medal of the National Aeronautics and Space Administration (NASA) for his first historic space flight. In 1971, he became a rear admiral, the first astronaut promoted to this rank. In 1974, Shepard resigned from the astronaut programme and the Navy.

Shepard, Ernest (1879-1976), was a British painter and illustrator. His illustrations for the *Pooh* stories and poems by A. A. Milne are particularly well known. He also illustrated several stories by Kenneth Grahame, in-



Illustration by Ernest Shepard; © 1926, renewed 1954. E.P. Dutton & Co. and McClelland and Stewart Ltd.

Ernest Shepard's best-known illustrations were for A. A. Milne's *Winnie-the-Pooh*.

cluding *The Wind in the Willows* and "The Reluctant Dragon," as well as books for older readers. He wrote and illustrated an autobiography, *Drawn from Memory* (1957). Shepard was born in London. Early in his career, he worked as a staff cartoonist for the magazine *Punch*.

Shepard, Sam (1943-), is an American playwright and film actor. His best-known plays portray American society as dead, decaying, or destructive. Most of Shepard's works combine symbolism and ritual with elements of popular culture, such as the Wild West, rock music, detective stories, and the cinema. Shepard has acted in several films, including *Days of Heaven* (1978), *Frances* (1982), *The Right Stuff* (1983), and *Country* (1984).

Shepard won the 1979 Pulitzer Prize for drama for *Buried Child* (1978). This grim play concerns a young man and his girlfriend who visit the man's grotesque family in the rural Midwest. Shepard also presented a nightmarish view of the American family in *The Curse of the Starving Class* (1977). He used rock music in *The Tooth of Crime* (1972), a symbolic story about the rivalry between two rock music stars. Shepard's later plays include *Fool for Love* (1983), *A Lie of the Mind* (1985), and *States of Shock* (1991).

Shepard was born in Fort Sheridan, Illinois. He grew up in southern California. When he was 19, he left home and changed his name from Samuel Shepard Rogers to Sam Shepard. After living in New York City and London for several years, he became resident playwright at the Magic Theater in San Francisco.

Shepherd. See *Sheep*.

Shepherd dog. See *Sheepdog*.

Shepparton (pop. 31,171) is a city in Victoria, Australia. It is situated on the Goulburn River, about 180 kilometres north of Melbourne. It is the main city of the rich Goulburn Valley and the centre of the Goulburn Valley Irrigation Scheme. Shepparton has a number of industries, an excellent shopping centre, and a wide range of sporting and cultural facilities, including a civic centre and art gallery.

Shepparton was originally called *McGuire's Punt*. In 1853, it was renamed *Shepparton* after the pioneer Sherbourne Sheppard, who settled in the district in 1843. It was declared a city in 1949.

Sheppey, Isle of. See *Swale*.

Shepway (pop. 89,200) is a local government district in England that includes a popular tourist area on the Kent coast. Folkestone, the district's largest town, has a race-



Astronaut Alan B. Shepard, Jr., was the first American in space. He also commanded the Apollo 14 moon landing.



A miniature steam railway in Shepway district attracts many travellers. The railway, which is claimed to be the world's smallest public railway, runs between Hythe and Dungeness.

course and passenger ferry services to France. Many tourists visit Hythe or New Romney to use the steam railway line that links these towns with Dungeness. Romney Marsh is an important sheep-farming area.

See also **Kent**.

Sher Shah Suri (1486?-1545) was an Afghan adventurer who ruled northern India in the early 1500's as one of the Suri dynasty. He nearly overthrew the Mughal Empire (see **Mughal Empire**). But as a result of his firm period of government, the empire was eventually strengthened and consolidated.

He was born in Sasaram, India. His original name was Farid Khan. He rose from obscurity and achieved prominence through service to the Mughals. While Emperor Humayun was distracted, Farid Khan captured Bihar in 1533, and Bengal in 1537. He then resisted two attempts to dislodge him, in 1539 and 1540. Humayun fled into exile and Farid Khan assumed the title of "Farid-ud-Din-Sher Shah." He proved to be a gifted administrator.

Sher Shah Suri was killed in battle while trying to extend his territory, but his reforming achievements were of lasting benefit to Humayun's son Akbar.

Sheraton, Thomas (1751-1806), was an English furniture designer. His reputation is based chiefly on a book of influential furniture designs called *The Cabinet-Maker and Upholsterer's Drawing Book* (1791-1794). Like other design books of the late 1700's, the *Drawing Book* recorded current tastes in furniture styles. Furniture that followed the styles in the book became known as Sheraton.

Furniture in the Sheraton style was popular in England from about 1790 to 1805 and in the United States

from about 1795 to 1810. The style featured straight outlines, slender legs, and simple decorations. A typical Sheraton chair has a rectangular back. Common decorations include diamond and oval shapes and designs that suggest lyres or vases. Sheraton was born at Stockton-on-Tees, Cleveland, England.

See also **Furniture** (English neoclassical furniture). **Sheridan, Philip Henry** (1831-1888), was a leading Union general in the American Civil War (1861-1865). He became famous especially for his victories as a cavalry leader in the Shenandoah Valley of Virginia.

Sheridan was born in Albany, New York. In 1853, he graduated from the United States Military Academy. Sheridan was a captain when the Civil War began. In late 1862 and early 1863, he commanded a Union infantry division in battles at Perryville, Kentucky, and Stones River (Murfreesboro), Tennessee. Sheridan's performance in these important battles earned him a promotion to major general of volunteers.

In 1863, Sheridan took command of a corps in the Army of the Cumberland. He led this corps in a battle at Chickamauga, Georgia. Later in 1863, in Tennessee, Sheridan's corps broke the Confederate line at Missionary Ridge in the Battle of Chattanooga. Sheridan's action allowed Union Gen-



Philip H. Sheridan

eral Ulysses S. Grant to win the battle. In 1864, Grant gave Sheridan command of the cavalry of the Army of the Potomac. In this command, he led a successful raid against Confederate forces in Richmond, Virginia.

In August 1864, Grant gave Sheridan command of all Union forces in Virginia's Shenandoah Valley. Grant ordered Sheridan to drive Confederate forces out of the valley and to destroy the valley's economic resources so that Confederate troops could not use them. In the valley, Sheridan's forces defeated Confederate troops under Lieutenant General Jubal A. Early at Winchester, Fisher's Hill, Waynesboro, and Cedar Creek. In April 1865, Sheridan helped Grant defeat Confederate General Robert E. Lee's forces at Five Forks, Virginia. This victory helped force Confederate troops to retreat from Richmond and Petersburg, Virginia.

After the Civil War, Sheridan commanded troops in the Southern United States. From 1869 to 1883, he commanded the Division of the Missouri and became the foremost frontier general and Indian fighter in the country. In 1884, Sheridan succeeded William T. Sherman as general-in-chief of the U.S. Army.

Sheridan, Richard Brinsley (1751-1816), was an Irish dramatist and politician. During his brief writing career, he produced several sparkling comedies. In later life, he was a brilliant speaker in the British Parliament.

While in his early 20s, Sheridan wrote *The Rivals* (1775). This comedy has a memorable character named Mrs. Malaprop who is a genius at using words incorrectly, as when she says, "Illiterate him, I say, quite from your memory." *The School for Scandal* (1777), Sheridan's finest play, is one of the great comedies of English drama. With glittering wit, the play exposes society people who love malicious gossip. It also contrasts a careless but kind young man, Charles Surface, with his scheming and selfish brother Joseph. *The Critic* (1779), a short satiric play, attacked theatrical fashions in a witty manner. Sheridan's other plays include the farce *St. Patrick's Day* (1775) and a comic opera *The Duenna* (1775). He also adapted Sir John Vanbrugh's comedy *The Relapse* into *A Trip to Scarborough* (1777).

Sheridan was born in Dublin, the son of an actor-manager, and grew up in England. He eloped with a beautiful singer in 1772, and fought two duels because of her. In 1776, he became manager of the Drury Lane theatre. In 1780, Sheridan was elected to Parliament. From that date until 1812, he devoted himself to politics. A gifted orator, Sheridan made a memorable speech in the trial of Warren Hastings (see *Hastings, Warren*). A man of great charm and wit, Sheridan lived a busy social life among the rich and the powerful. He is best remembered for his witty plays, but he spent little of his life as a writer.

Sheriff and bailiff. In England and Wales, the *high sheriff* is the chief officer of the Crown in each county. In

Scotland, a *sheriff* is a judge in a local court. Scottish sheriffs are trained lawyers and have the jurisdiction to try civil and criminal cases.

In the United States, a sheriff is one of the chief administrative officers of a county. A sheriff's duties include taking charge of prisoners, overseeing juries, and preventing breaches of the peace. A sheriff also carries out the judgments of the county court. For example, if the court gives a judgment against a debtor, the sheriff seizes that person's property and sells it to satisfy the claims of creditors.

The word *sheriff* comes from old England. Each *shire*, or county, had a chief officer known as a *reeve*. The title *shire reeve* gradually came to be run together in the single word *sheriff*. A *bailiff* in England and Wales is appointed by a sheriff to serve writs, warrants, and summonses. In present-day Jersey and in Guernsey, the bailiff is the chief civil officer of the island. The offices of sheriff and bailiff originated in Saxon times.

Sherman, John (1823-1900), was an American statesman. He became noted for introducing the silver and antitrust laws that bear his name (see *Antitrust laws*). For almost 50 years Sherman held office in Washington, D.C., either as a Republican member of Congress or in the Cabinet. He was elected to the House of Representatives from Ohio in 1854, and seven years later was elected to the Senate. Sherman served as secretary of the treasury from 1877 to 1881, and then returned to the Senate. His last public office was as secretary of state in 1897 and 1898.

Sherman was born in Lancaster, Ohio. During the Civil War (1861-1865), Sherman's brother William T. Sherman became a famous Union general (see *Sherman, William T.*).

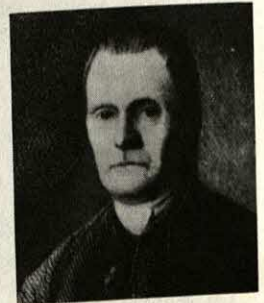
Sherman, Roger (1721-1793), was the only person who signed all four of the great documents of the American Revolution: the Articles of Association (1774), the Declaration of Independence (1776), the Articles of Confederation (1777), and the Constitution of the United States (1787). Sherman was born in Newton, Massachusetts. In 1743, he moved to Connecticut, where he became prominent in business and politics. Sherman was judge of the Connecticut Superior Court from 1766 to 1789.

When the American independence movement began, Sherman was among the first to deny the supremacy of the British Parliament over the American Colonies. He was influential in the Second Continental Congress, where Massachusetts patriot leader John Adams said he was "as firm in the cause of

American Independence as Mount Atlas." During the Constitutional Convention of 1787, Sherman presented the *Great Compromise*. This measure, sometimes called the *Connecticut Compromise*, resolved the differences between the large and small states on representation in the national legislature. He served his state in the U.S. Congress as a repre-



Richard Brinsley Sheridan



Roger Sherman

sentative from 1789 to 1791 and as a senator from 1791 to 1793.

Sherman, William Tecumseh (1820-1891), was a leading Union general in the American Civil War (1861-1865). He became most famous for his "march to the sea," across Georgia, in 1864 and for his march through the Carolinas in 1865. On these marches, Sherman's troops destroyed much of the South's military and economic resources. From 1869 to 1883, Sherman served as commanding general of the United States Army.

In 1864, Sherman led an army that captured Atlanta, Georgia, and burned parts of the city. He then began his "march to the sea." On the march, his troops stripped barns, fields, and some houses. The march ended at Savannah, Georgia. Sherman then marched north through South Carolina and North Carolina. In April 1865, General Joseph Johnston surrendered to Sherman near Durham, North Carolina. But President Andrew Johnson thought the terms granted by Sherman were too generous and rejected them.

Sherman was born in Lancaster, Ohio. In 1840, he graduated from the United States Military Academy at West Point. After the Civil War, both the Democratic and Republican parties repeatedly asked him to run for president, but he refused.

Sherpas are a people who live mainly in the mountains of the Himalayan range in northeast Nepal. Many of the approximately 25,000 Sherpas live near Mount Everest, the world's highest mountain. Some Sherpas live in northeast India.

The Sherpas have traditionally made their living by farming. Their chief crop is potatoes, but they also grow barley, maize, and wheat. Sherpas also rear *yaks*, a type of ox that thrives in high altitudes. Since the early 1950's, many Sherpas have worked as guides for tourists and porters for mountain climbing expeditions in the Himalaya. In 1953, a Sherpa named Tenzing Norgay and a New Zealand climber named Edmund Hillary became the first people to reach the top of Mount Everest.

Most Sherpas cannot read or write. But since the early 1960's, the Sherpas have built schools in several villages. As a result, some Sherpa children have attended secondary school, and a few have gone on to college.

The Sherpas probably moved to Nepal in the early 1500's from eastern Tibet. They still follow many of the customs and traditions of their Tibetan ancestors. For example, the Sherpa language is a Tibetan dialect. Most Sherpa women and some Sherpa men dress in Tibetan clothing. The Sherpas practise a form of Buddhism called *Lamaism*, which is the traditional religion of Tibet.

Sherritt, Aaron (1857?-1880), an Australian, was described as "friend and bush telegraph of the Kelly gang." He was killed by Joe Byrne, one of the gang. See *Kelly, Ned*.

Sherritt attended the Woolshed school near Beechworth, Victoria, with Byrne. The two were close friends and were often in trouble. Sherritt courted Byrne's sister and Ned Kelly's sister, Kate, but married Ellen Barry early in 1880. When police began hunting the Kelly gang, Sherritt acted as a double agent. Joe Byrne learned of Sherritt's treachery and resolved to kill him.

On Saturday night, June 26, 1880, four police were hiding in Sherritt's slab hut at Sebastopol, near Beech-

worth. There was a knock at the door, and Sherritt recognized the voice of a German neighbour, Anton Wicks, who claimed to have lost his way in the darkness. On opening the door, Sherritt was gunned down by Joe Byrne. His companion, Steve Hart, was covering the other door. The pair had captured Wicks and used him as a decoy. Aaron Sherritt was buried in Beechworth cemetery.

Sherwood, Robert Emmet (1896-1955), was an American playwright, journalist, and biographer who stressed the evils of war in his writings. His play *Idiot's Delight* (1936) lamented the approaching outbreak of war in Europe. *Abe Lincoln in Illinois* (1938) used Lincoln's own words to show the necessity of firm action in the face of war. *There Shall Be No Night* (1940) opposed the Soviet Union's invasion of Finland. It was also Sherwood's stand against what he called the hysterical desire of people to escape from reality. All three of these plays won Pulitzer Prizes.

Sherwood was born in New Rochelle, New York. In 1920, he joined *Life* magazine. He became a nationally-known film critic at *Life*, and was the magazine's associate editor from 1924 to 1928.

Sherwood's first produced play, *The Road To Rome* (1927), was a satire on Hannibal's campaign against Rome. It said every sacrifice in the name of war is wasted. *The Petrified Forest* (1935) showed criminal morality triumphing in the world. During World War II (1939-1945), Sherwood wrote speeches for President Roosevelt. He won a Pulitzer Prize for his biography *Roosevelt and Hopkins: An Intimate History* (1948).

Sherwood Forest, in eastern England, is associated with the legendary hero Robin Hood. At one time, it extended from Nottingham as far north as Whitby, in North Yorkshire. Today, what remains of the forest lies mainly in Nottinghamshire.

Shetland is a group of more than 100 islands that lie about 160 kilometres northeast of the Scottish mainland. Shetland is administered by an island council authority, which was set up in 1975 as part of the reorganization of Scotland's local government. More than half of the people live on Mainland, the largest island. Only 10 of the other islands are inhabited. Lerwick, on the east coast of Mainland, is the administrative centre. It has one-third of the total population.

Before the development of the oil industry in the 1970's, the only industries were agriculture, fishing, and knitting, particularly the famous Shetland and Fair Isle patterns. Some people believe that the survivors of a Spanish galleon wrecked in 1588 originally taught the islanders the Fair Isle patterns.

Oil industry. Shetland is an important base for servicing the North Sea oil industry. Growth of this industry caused many changes in Shetland from the 1970's. Many people gave up farming or fishing to work in the oil industry. Lerwick's harbour has been greatly expanded to accommodate service vessels. Sumburgh Airport has heavy helicopter traffic to the oil rigs. Sullom Voe, an inlet at the northern end of Mainland, has a vast oil terminal for pipelines from North Sea oilfields.

Agriculture and fishing. Farmers in Shetland are *crofters* who cultivate only a small area (see *Crofter*). Some have small flocks of hardy sheep and a few cattle. Farmers also export Shetland ponies.



Shetland was under Norse control until 1469. Many Norse names and customs remain, including the Viking fire festival, *Up-Helly-A'*, in which a Viking galley is ritually burnt.

Since 1981, the fishing industry has flourished. The main species caught are cod, haddock, herring, mackerel, and whiting. Shetland's fish farming industry grew rapidly in the 1980's. By the early 1990's, it had become the most important source of fish in the islands.

Manufacturing. Since the 1500's, the people have used the extremely fine Shetland wool to make woollen cloth and knit high-quality garments. Fish processing is another important industry.

Transportation and communication. Ships travel regularly between Aberdeen and Lerwick. The 340-kilometre journey takes about 14 hours. There are direct air links with Orkney, Aberdeen, Inverness, Edinburgh, and Glasgow. Ships regularly travel between Mainland and other islands. Boat services link Shetland with Denmark, Norway, the Faeroe Islands, and Iceland during summer. A weekly newspaper, the *Shetland Times*, is published in Lerwick. Radio Shetland is a BBC station.

Things to see and do. Tourism is important. Thousands of sea birds attract naturalists to the islands. Places of special interest in Shetland include Scalloway Castle, built in the 1600's, and the Jarlshof archaeological excavations near Sumburgh. Shetland has fine facilities for those interested in angling, bathing, and tennis.

Land. Shetland's islands extend for about 115 kilometres from north to south and about 60 kilometres from east to west. The principal island, Mainland, is about 85 kilometres long. Much of the islands' surface is bleak,

treeless moorland. The highest peak is Ronas Hill, 450 metres above sea level, on Mainland.

Climate. In Shetland, summers are cool and winters are mild. Temperatures average about 3° C in winter and 13° C in summer. The islands have many storms.

History. The Norsemen (Vikings) settled in Shetland in the A.D. 700's and 800's. Many Shetland people and places have names that come from old Norse words. Some Norse customs remain, including *Up-Helly-A'*, the fire festival in January. Shetland remained under Norse control until 1469, when King James III of Scotland married Margaret, daughter of Christian I, the king of Denmark, Norway, and Sweden. Shetland then came under Scottish rule.

Shetland pony is one of the smallest breeds of horses. A Shetland stands from 80 to 115 centimetres high at the shoulder. The breed originated on the Shetland Islands off the coast of Scotland. Early Shetlands had thick bodies and legs. These strong ponies were



Shetland's Viking history is recalled when islanders wear Viking costumes in the *Up-Helly-A'* festival each January.

Facts in brief about Shetland

Administrative centre: Lerwick.

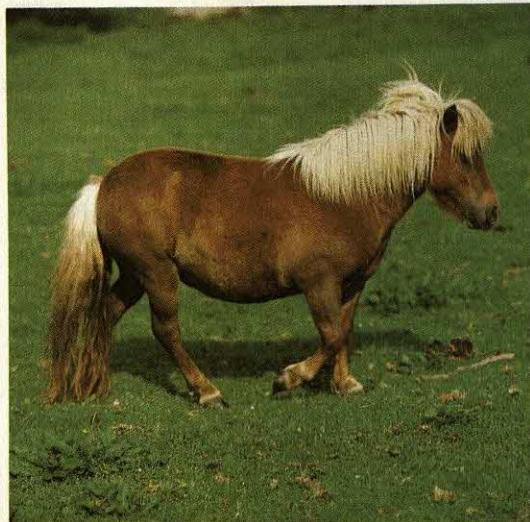
Largest town: Lerwick.

Land area: 1,425 km².

Population: 1991 census—22,522.

Chief products: Fish, knitwear, sheep.

Motto: *Medh lögum skal land byggja* (By law is the land established).



The Shetland pony is one of the smallest breeds of horses. Long, thick hair protects these animals from cold and dampness.

used as saddle and pack animals. They also pulled carts in coal mines.

Some Shetlands have been allowed to retain the powerful build of the original Shetlands. Others have been crossbred with lighter ponies to produce animals with more slender and graceful features. However, all Shetlands have thick manes and tails. Most are black or brown in colour. People usually keep Shetlands as pets or as children's mounts.

Shetland sheepdog is considered one of the most beautiful of all herding dogs. It is short, standing only from 33 to 40 centimetres high. It was bred to herd the small livestock of the Shetland Islands. The Shetland looks dainty and fragile, but it is a rugged dog, capable of hard work. The Shetland looks somewhat like a miniature collie. It makes a good pet and an excellent watchdog. See also **Dog** (picture: Herding dogs).

Shevardnadze, Eduard Amvrosiyevich (1928-), was elected chairman of the parliament of the country of Georgia in 1992. As chairman, he is Georgia's most powerful government leader. From 1985 to 1990, Shevardnadze served as minister of foreign affairs for the Soviet Union. In this post, he led an effort to reform Soviet foreign policy by moving away from strict Communist principles. He resigned in 1990, complaining of criticism of his reform efforts and warning of the threat of dictatorship.

Formerly a republic of the Soviet Union, Georgia declared its independence in April 1991. Zviad Gamsakhurdia was elected president in May. Opposition leaders accused Gamsakhurdia of moving toward dictatorship, and the



Eduard Shevardnadze

president was replaced by a military council in January 1992. In March, the council invited Shevardnadze to head the government until elections could be held in October. After winning in the elections, Shevardnadze worked to end ethnic fighting in Georgia.

Shevardnadze was born in Mamati, in Georgia. He joined the Communist Party in 1948. He served as leader of Georgia's Communist Party from 1972 to 1985. In 1985, he became a voting member of the Politburo, the chief policymaking body of the Soviet Communist Party. **Shevchenko, Taras**, (1814-1861), was a Ukrainian patriot who became Ukraine's most famous poet. His poems stress the hard life of Ukrainians and their desire for independence from Russia. Shevchenko's writing is colourful and often includes everyday language. He is considered the founder of modern Ukrainian literature.

Shevchenko was born a serf in the village of Morintsy, near Kiev. In 1838, wealthy admirers bought his freedom while he was studying art in St. Petersburg. Shevchenko wrote against serfdom and monarchy. In 1847, the Russian government punished him by forced military service in the Ural Mountains, where he stayed 10 years. His works include *Minstrel* (1840), *Katerina* (1840), *Haydamaki* (1841), and *Dream* (1844).

Shi Huangdi, (259?-210 B.C.), also spelled *Shih Huang-ti*, was an emperor of China. He created the first united Chinese empire, founded the Qin *dynasty* (a series of rulers of the same family), and began construction of the Great Wall of China.

Shi Huangdi became ruler of the Chinese state of Qin in 247 B.C. Between 234 and 222 B.C., he conquered other states and replaced local rule with a strong central government. In 221 B.C., he proclaimed himself China's first emperor. To keep out northern invaders, he linked short walls built by earlier rulers, marking the start of the Great Wall of China. Shi Huangdi ruled harshly. He executed many who opposed him and used forced labour to build the Great Wall. He burned writings that might have turned people against him. The Qin dynasty fell from power in 206 B.C.

See also **Great Wall of China; Qin dynasty**.

Shiba inu is a small dog that originated thousands of years ago as a hunting dog in Japan. The name *shiba inu* is Japanese for *brushwood dog*. The shiba inu stands 34 to 42 centimetres tall and weighs up to 11 kilograms. It has a thick, muscular neck, and its tail curls up over the back. The shiba has a soft, dense undercoat and a stiff outer coat. Common coat colours are red and black or black and tan, with white or cream markings.

Shield was the chief means of personal protection in war from earliest times until the invention of firearms during the 1300s. Shields were carried in one hand or on the arm to ward off enemy blows. The other hand was free to use a club, sword, or spear.

The earliest shields were made of leather or wood. Some were covered with metal. They were of many sizes and shapes. The ancient Egyptians had large shields that were often oblong in shape with a curved top. Sumerian and Assyrian shields were round. The ancient Greek soldier carried a heavy round or oval shield that had a reinforced grip. The Romans introduced a rectangular curved shield made of leather-covered wood.

During the Middle Ages, armoured knights used a



Shields used by soldiers, noblemen, and warriors varied in size, shape, and design. Many decorated shields served not only for protection in battle but also to identify the owner.

small triangular shield. After helmets covering the face were introduced, a knight was recognized by the coat of arms painted on his shield. Foot soldiers carried a small round shield called a *buckler*. Archers reloaded their bows behind a *pavis*, a large shield set on the ground. In the 1300's, knights began wearing *plate armour* consisting of large pieces of steel, and they no longer needed shields. Shields were also discarded because they offered little protection against guns.

Today, police officers sometimes carry shields made of synthetic materials for protection during riots.

Shifting cultivation. See Agriculture (Subsistence agriculture); Tropical rainforest (People and the rainforest).

Shigellosis. See Dysentery.

Shih Huang-ti. See Shi Huangdi.

Shih Tzu is a breed of toy dog related to the Pekingese and Lhasa apso. It comes from China, particularly the area of Tibet. The Shih Tzu has a broad head and large, dark eyes. Its drooping ears are fringed with long hair, and its snout is short and square. The dog's thick

coat may be any colour. The dog grows 23 to 27 centimetres high and weighs 5 to 7 kilograms.

Shiites are the followers of the Shia division of Islam. The Shiites belong to the smaller of the two major divisions of Islam, with less than 20 per cent of the believers. The other division is called Sunni, and its followers are called Sunnis. Azerbaijan, Bahrain, Iran, and Iraq are the only Islamic countries with a Shiite majority.

The Shiite origins lie in the controversies about the leadership of the Islamic community after the death of the Islamic prophet Muhammad in A.D. 632. A majority of *Muslims* (followers of Islam) supported the election of Abu Bakr, one of Muhammad's prominent disciples, as *caliph* (leader or successor). This group became the Sunnis. However, a minority argued that leadership should have gone to Ali, Muhammad's cousin and closest surviving male relative, who was also the husband of Fatima, the prophet's daughter. This group, the *Shiah Ali* (Party of Ali), became the Shiites. They accused Abu Bakr and the two rulers who followed him of wrongfully seizing power from Ali.

The Shiites give the title *Imam* to the person they believe to be the rightful leader of Islam. According to Shiite teaching, the Imam is a spiritual, as well as an earthly, leader. Each new Imam must be a direct descendant of Ali. The Shiites believe that the Imam is the continuing source of divine guidance in the world.

Ali was the first Imam. Following his assassination in 661, his son, Hasan, became Imam. Ali's second son, Husain, succeeded Hasan. The most important Shiite holy day practice observes mourning for the death of Husain at the hands of the caliph's troops in 680.

See also Islam; Muhammad; Muslims; Sunnis.

Shilling was a coin in the British money system. It was equal to 12 pence, and was $\frac{1}{20}$ of a pound sterling. The shilling was replaced in 1971 by a coin of equal value, the five new pence piece. However, the shilling is still the monetary unit of some African countries.

Shingle-backed lizard derives its name from the large pine-cone-shaped scales on the upper surfaces of its body. The head is wedge-shaped, and the body is stout and heavy. Shingle-backed lizards have short, stumpy tails that act as fat reservoirs during hibernation.



The Shih Tzu is a tiny dog that originated in Tibet.



Shingle-backed lizards are found from far inland to the coast of New South Wales, Victoria, and South Australia. Their shingles are shaped like pine cones.

Their colour varies from yellowish to totally black, with many shades in between. Shingle-backed lizards grow to about 50 centimetres in length. When approached, they usually emit a loud hiss, exposing their bright blue tongues.

Scientific classification. The Shingle-backed lizard belongs to the skink family Scincidae. It is *Tiliqua rugosa*.

Shingles. See Herpes.

Shingon. See Buddhism (The Mantrayana).

Shinto is the oldest surviving religion of Japan. The word *Shinto* means *the way of the gods*. Shintoists worship many deities, which are called *kami*. According to Shinto, *kami* are the basic force in mountains, rivers, rocks, trees, and other parts of nature. Shinto also considers *kami* the basic force in such processes as creativity, disease, growth, and healing.

Shinto emphasizes rituals and moral standards. It does not have an elaborate philosophy, and it does not stress belief in life after death.

On certain occasions, Shinto priests lead ceremonies called *matsuri*. One of the most important Shinto rituals is the Great Purification Ceremony. It consists of a confession of sins committed by individuals and by the nation as a whole, followed by a request that the *kami* remove the impure conditions caused by these sins. Other ceremonies deal with such basic goals as long life, peace, abundant harvests, and good health.

No one knows when or how Shinto began. But Shintoists have always worshipped the *kami* through nature. Shinto myths appear in the *Nihongi* (*Chronicles of Japan*) and the *Kojiki* (*The Record of Ancient Matters*), both written in the A.D. 700's. These myths tell how the *kami* created the world and established customs and laws. According to Shinto mythology, the sun goddess became the ancestor of Japan's imperial family.



A wooden gate called a *torii* is the symbol of Shinto. A *torii* stands at the entrance of a Shinto shrine. It consists of two posts connected by crossbars. The posts represent pillars that support the sky, and the crossbars symbolize the earth.

Beginning about the A.D. 500's, the Chinese philosophies of Buddhism and Confucianism influenced Shinto. Shintoists identified Buddhist gods as *kami*, and shrines adopted Buddhist images to represent the *kami*. Buddhist ceremonies were used for funerals and memorial services. Under the influence of Confucianism, Shinto developed such moral standards as honesty, kindness, and respect for one's elders and superiors.

During the 1800's, many Shintoists began to reject the Buddhist influence. In the mid-1800's, a movement called *State Shinto* stressed patriotism and the divine origins of the Japanese emperor. After Japan's defeat in World War II in 1945, the emperor denied that he was divine, and the government abolished State Shinto.

Later movements of Shinto, called *New Religions*, attracted many followers in Japan during the 1800's and 1900's. The New Religions centre around the teachings of a particular person or group. Some of them encourage group worship, charity work, and the organization of society on a cooperative basis.

See also **Japan** (Religion); **Religion** (picture: A Shinto festival).

Shinty is a game played in Scotland. It is also called *camanachd*. There are 12 players to a side. The game is similar to hockey, but the players use a shorter stick called a *caman*. Each side aims to score by putting the ball through a *hail* (goal) 4 metres wide and 3 metres high. A game is divided into halves of 45 minutes. Players may hit the ball with either side of the *caman*, whether the ball is in the air or on the ground. Shinty is faster and more violent than hockey. The main competition is for the Camanachd Association Challenge Cup.

Shinwell, Emanuel (1884-1986), was a distinguished British Labour Party politician and statesman. As minister of fuel and power from 1945 to 1947, he carried out the nationalization of Britain's coal mines.

Shinwell was born in London, and moved to Scotland as a boy. He first entered Parliament, for the Scottish constituency of Linlithgow, in 1922.

Shinwell held top ministerial posts in fuel and power, war, and defence in the Labour government from 1945 to 1951. He was chairman of the Parliamentary Labour Party from 1964 to 1967. He became a life peer in 1970. Shinwell wrote several books, including *The Britain I Want* (1943), *Lead with the Left* (1981), and the autobiographical *My First Ninety-Six Years* (1981).



Sturdy cargo ships like these freighters in the harbour at Rotterdam, the Netherlands, are the workhorses of the sea. They carry much of the trade among the countries of the world.

Ship

Ship is one of the oldest and most important means of transportation. Every day, thousands of ships cross the oceans, sail along seacoasts, and travel on inland waterways. Trade among countries depends heavily on ships. For example, ships carry wheat from Canada to Germany and machinery from Germany to Chile. They carry copper from Chile to Japan and Japanese cars to Europe and Australia. Ships transport American maize to Ethiopia, coffee from Ethiopia to France, and French plastics to Canada.

Many kinds of ships are used to carry the world's trade. Giant tankers carry petroleum, vegetable oil, wines, and other liquids. Refrigerator ships carry fresh fruits, meats, and vegetables. Vessels called *dry bulk carriers* haul such cargoes as grain, ore, and sand. General cargo ships transport everything from aeroplane engines to zip fasteners. Passenger liners carry travellers across the oceans and tourists on cruises around the world.

For several thousand years, people have gone down to the sea in ships. They have been drawn by the mysteries of the sea and by its promise of adventure. More important, people have sailed the seas to explore, to settle, to trade, and to conquer.

Europeans, Arabs, Chinese and other people built sea-going ships in the Middle Ages, for trade and exploration. The first ocean explorers from Europe were the Portuguese, who sailed into the Atlantic and southwards to the west coast of Africa in the late 1400's. In 1492, Christopher Columbus, an Italian in the service of the king of Spain, braved the Atlantic Ocean in three small sailing ships and reached the New World. In 1497, a Portuguese navigator, Vasco da Gama, sailed from Europe

to India. Arab and Chinese ships were already sailing across the Indian Ocean to trade between Africa, India, and eastern Asia.

An old trading ship called the *Mayflower* took the first Pilgrim settlers to North America in 1620. From the 1600's to the 1800's, big sailing ships called *East Indiamen* carried silks, spices, and other riches from the Far East to Europe. During the mid-1800's, steam-powered ships began to replace sailing vessels. The world quickly became smaller as steamships crossed the seas in a fraction of the time that sailing ships needed. Thus, ships have brought countries and peoples closer together and made them dependent economically on one another.

Throughout history, nations have become rich and powerful by controlling the seas in war and peace. When countries have lost that control, they have declined. Today, ships are as important as ever to a country's prosperity and strength. The world's leading trading nations depend largely on ships for imports and exports. The economies of Great Britain, Japan, Germany, and many other countries would soon be badly crippled if there were no ships to bring in food and raw materials and to carry out manufactured goods. Many trading nations have a large *merchant navy*. A merchant navy consists of the commercial, or merchant, ships of a country.

The difference between a ship and a boat is chiefly a matter of size. Large oceangoing vessels are called *ships*. All other craft are called *boats*.

This article deals mainly with merchant vessels. For information on naval vessels, see the *World Book* articles on *Navy* and *Warship*. For information on pleasure boats, see *Boating*.



Luxurious cruise ships sail to the Caribbean and Mediterranean seas and on round the world trips. They provide fine food, excellent accommodation, and a variety of recreational activities.

History

The first "ship" was probably a log that was used to cross a lake or river. People probably used their hands as paddles. Later, people learned to build rafts by lashing logs together. In time, they discovered how to make dugouts and bark canoes. In regions where wood was scarce, early people made boats of other materials. For example, they sewed animal skins into a bag, which they then inflated and used as a float. Several floats tied together could support a raft. In some areas, the people found that little clay pots tied together could hold up a raft. They also learned that a large pot made a boat for one person.

In ancient Egypt and certain other regions, the people made their first rafts of bundles of reeds. In time, the Egyptians learned to lash bundles of reeds together to make boats that had a spoonlike shape. By about 4000 B.C., they had learned to build *galleys*—long, narrow craft powered by a row of paddlers. During the next 1,000 years, the Egyptians made two more great advances in the development of ships. By about 3000 B.C., they had discovered that sails could harness the wind and propel their boats. In addition, the Egyptians had learned to build boats out of planks of wood. After people knew how to make plank boats, they could even build ships—vessels that are big enough to cross the oceans.

The age of sailing ships

The basic pattern for ships became set with the invention of the sail and then of the vessel built of planks. For about the next 5,000 years, shipbuilders concentrated on designing bigger and bigger ships and on improving the *rig*—the sails with their masts and ropes. Shipbuild-

ers of ancient times succeeded in building ever-larger ships, but they made little progress with the rig. Big improvements in the rig began during the 1400's and reached a high point with the development of the great sailing ships of the mid-1800's.

Egyptian ships. The ancient Egyptians designed many kinds of vessels, including small graceful canoes,

Some important dates in ship development

- 3000's B.C.** The Egyptians invented sails and learned to build boats out of planks of wood.
- c. A.D. 1200** Shipbuilders in northern Europe introduced the stern rudder.
- c. 1450** Mediterranean shipbuilders developed the full-rigged sailing ship.
- 1807** Robert Fulton of the United States built the first commercially successful steamboat.
- 1818** Great Britain launched the *Vulcan*, the first known all-iron sailing ship.
- 1819** The American ship *Savannah* became the first steam-powered vessel to cross the Atlantic Ocean, though it used its engines only 105 hours during the 29-day voyage. The *Savannah* used sails the rest of the trip.
- 1836** Francis Pettit Smith, an Englishman, and John Ericsson, a Swede, patented propellers to drive steamboats.
- 1838** Great Britain's *Sirius* became the first ship to offer regular service across the Atlantic Ocean under steam power alone.
- 1897** Charles A. Parsons of England demonstrated the efficiency of steam turbines in his launch, the *Turbinia*.
- 1910-1911** The first motorships went into operation.
- 1959** The United States launched the *Savannah*, the first nuclear-powered merchant ship.
- 1980** The tanker *Seawise Giant*, launched in 1979, was lengthened to become the world's largest ship, with a length of 458 metres.

Nautical terms

Aft means to the rear of. For example, abaft the mainmast means to the rear of the mainmast.

Aft means toward, at, or near the stern. To go aft is to go toward the stern.

Amidships means in the middle part of a ship, halfway between the bow and stern.

Ballast is the seawater or any other heavy substance carried in the deepest holds to help keep the ship stable.

Beam is the width of a ship at its widest point.

Below means under the main deck. To go below means to leave the main deck and go anywhere beneath it.

Binnacle is the stand that holds a ship's compass.

Bow is the front part of a ship.

Bridge is the elevated platform above the main deck from which a ship is navigated.

Bulkheads are walls that divide a ship into compartments.

Bulwarks are low metal walls built around the main and upper decks. Bulwarks help prevent waves from breaking over the decks. They also help keep people or objects from falling or being washed overboard.

Companionway refers to the steps that lead from one deck to another.

Crow's-nest is a small platform high on a mast from which a crew member keeps lookout.

Derricks are lifting devices that lower cargo into or hoist it out of the holds.

Draught is the depth of a ship in the water—the distance from the water line to the bottom of the keel.

Forecastle (pronounced *Fohk suhl*) is a raised deck near the bow. The term also refers to the crew's quarters in the forward part of a ship.

Forward means toward the front of a ship.

Freeboard is the distance between the water line and the main deck.

Funnel is the smokestack of a ship.

Hatch is an opening in the deck through which cargo is lowered into or hoisted out of a hold. A *hatch cover* fits over the hatch and keeps water from going below.

Helm is a ship's steering wheel.

Holds are areas below deck in which cargo is stored.

Keel is the backbone of a ship. It is a ridge that runs along the lowest part of the hull from the stem to the stern.

Lee side is the side of a ship away from the wind.

Moor means to keep a ship in place with ropes tied to a pier, to a buoy attached to an anchor, or to another ship.

Poop is a short raised deck at the rear of a ship.

Port is the left side of a ship when facing toward the bow.

Quarter refers to a section on each side of a ship near the stern.

Ship's bell signals the time aboard ship. On most ships, a day consists of six 4-hour *watches* (periods when crew members stand duty). The officers and crew have eight hours off duty after each watch. The watches change at 8 a.m., noon, 4 p.m., 8 p.m., midnight, and 4 a.m. A chime marks each half-hour. During a four-hour watch, one bell chimes at the first half-hour, two bells at the second, and so on up to eight. At the eighth half-hour chime, the next watch begins and the sequence starts over again.

Starboard is the right side of a ship when facing the bow.

Stem is the foremost part of a ship.

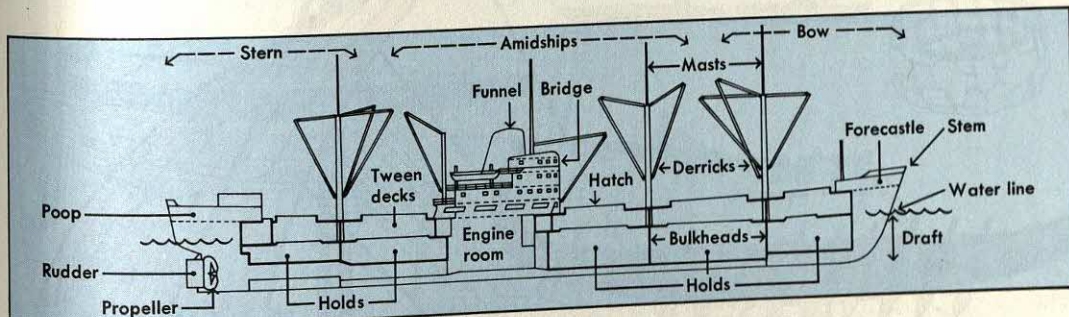
Stern is the rear part of a ship.

Superstructure consists of all the structures on a ship that rise above the main deck.

Tween decks are spaces above the holds of general cargo ships in which additional cargo may be stored.

Water line is the point on the hull that the surface of the water reaches.

Windward side is the side of a ship from which the wind is blowing.



Nautical measurements

Deadweight tonnage is a ship's actual carrying capacity measured in long tons. A long ton equals 1.016 metric tons. Deadweight tonnage includes cargo, crew, passengers, fuel, supplies, and spare parts. Freighters and tankers are generally described in terms of deadweight tonnage.

Displacement tonnage is the number of long tons of water displaced (occupied) by a ship. This measurement is generally used for naval craft.

Gross tonnage is the amount of a ship's enclosed space. It is a measure of volume, not weight, and is expressed in units of 100 cubic feet (2.8 cubic metres). A ship of 5,000 gross tons has 500,000 cubic feet (14,158 cubic metres) of enclosed space.

Passenger ships are usually measured in terms of gross tonnage.

Knot means one *nautical mile per hour*. A ship's speed is measured in knots. A nautical mile equals 1,852 metres, and a land mile equals 1,609 metres. Therefore, a ship that does 10 knots travels somewhat faster than 16 kilometres per hour. See **Knot**.

Net tonnage is the amount of revenue-producing space of a ship. The net tonnage of a ship is found by subtracting the engine room, the quarters of the crew, and all other areas on the ship that do not hold cargo from the gross tonnage. Net tonnage is used to determine harbour fees, taxes, and canal tolls.

beautiful pleasure boats, and heavy freighters. Their most outstanding achievement was probably the huge barges that carried enormous stone pillars called *obelisks* from quarries up the Nile River. The biggest barges measured more than 61 metres long and carried 680 metric tons of cargo.

One sail and a line of oarsmen on each side propelled the light Egyptian vessels. The heavier craft were driven by only a sail. The Egyptians used a rectangular sail, which is called a *square sail*. At first, they made the sail tall and narrow. But after 2000 B.C., they made it much wider than it was tall. The Egyptians steered their ships with large oars on each side near the *stern* (rear) of the vessel.

The Egyptians built their vessels chiefly for use on the River Nile. As a result, they made all their craft—even ships used on the sea—rather light. Today, boats of planks are built by first making a skeleton of *keel* (backbone) and ribs and then fastening the planks of the hull to the ribs. But the Egyptians built their river craft with-

out a keel or ribs. They simply fitted the planks together by means of joints to form the hull. These vessels were sturdy enough to sail on the Nile, but they were too weak for the rougher Mediterranean Sea.

The Egyptian seagoing ships probably had some kind of keel and a few ribs. But the bow and stern of these ships tended to droop, especially in rough seas. So the Egyptians wound a heavy rope around the *bow* (front), stretched it tightly across the deck, and looped it around the stern. The rope strengthened the vessels and kept the bow and stern from sagging. The Egyptians sailed chiefly on the Red Sea and along the eastern shore of the Mediterranean.

Minoan and Mycenaean ships. The Minoans, who lived on the island of Crete, became the first true seafaring people of the Mediterranean region. As early as 2500 B.C., their ships ranged the eastern Mediterranean and as far west as the island of Sicily. About 1450 B.C., the Mycenaeans, who lived on what is now the Greek mainland, won control of the sea. The Minoans and My-

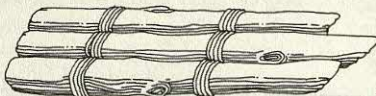
Prehistoric and ancient Egyptian ships

The first "ships" included dugouts, log rafts, and boats made of hides stretched over a frame. The ancient Egyptians made some of the greatest advances in the development of ships. By about 4000 B.C., they had learned to build long, narrow reed boats powered by a line of paddlers. By about 3000 B.C., the Egyptians had discovered how to make sails and how to construct boats of planks of wood. People could then build ships—vessels large enough to cross the open seas.

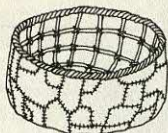
Dugout



Log raft



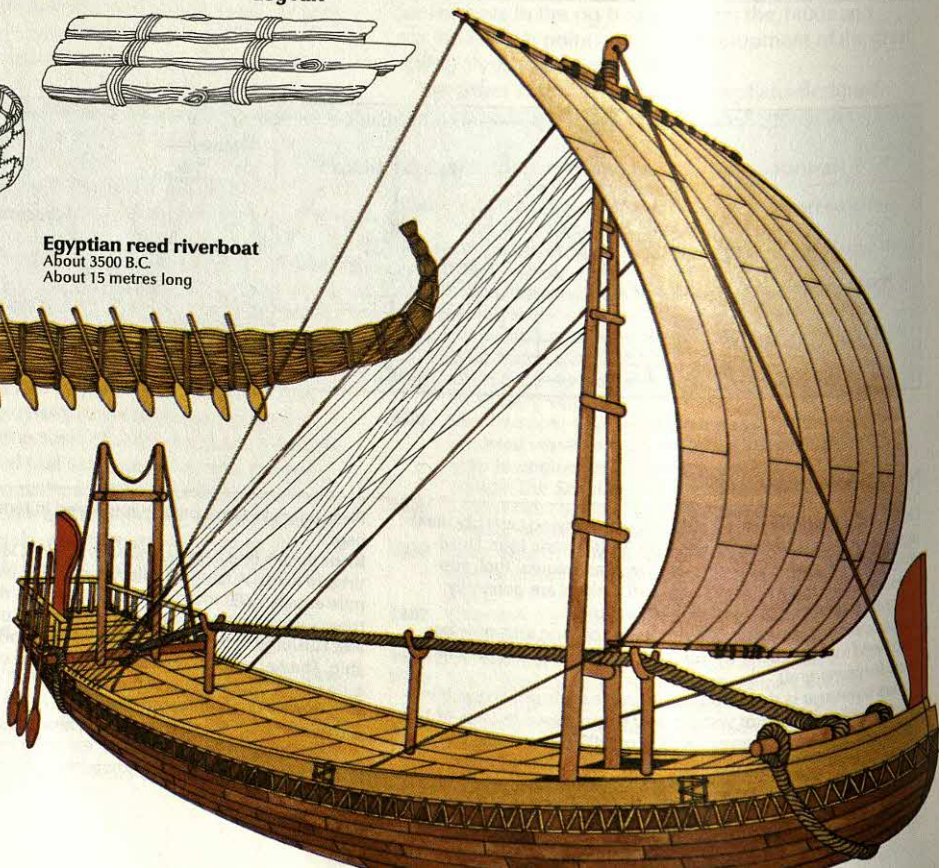
Hide boat



Egyptian reed riverboat
About 3500 B.C.
About 15 metres long



Egyptian wooden seagoing cargo ship
About 2500 B.C.
About 30 to 46 metres long



cenaeans both helped develop the seagoing sailing ship. But historians know little about their ships. All they know for sure is that these peoples built cargo vessels that were sturdy and roomy and had one square sail. The Minoans and Mycenaeans also built strong war galleys propelled by a row of oarsmen on each side.

Phoenician and Greek ships. Scholars know much more about the ships used on the Mediterranean Sea after about 1200 B.C. At that time, the leading seafaring peoples were the Phoenicians, who lived along the eastern shore of the Mediterranean, and the Greeks.

The Greeks and Phoenicians built broad, roomy cargo ships and greatly improved the ship rig. By about 500 B.C., they built vessels with two masts. The second mast sloped forward over the bow. It supported a small square sail that made steering easier. After 300 B.C., the Greeks set a triangular sail above the mainsail. On their biggest ships, they added another square sail near the stern. This simple four-sail rig was the most advanced rig ever developed by the peoples of ancient times. As a

result, ancient ships were slow and could travel at an average speed of only about 5 knots with the wind. The standard Greek freighter measured about 30 metres long and could carry 91 to 180 metric tons of cargo.

The Greeks used galleys as warships. Their earliest galleys had a line of rowers on each side. Between 1000 and 800 B.C., the Greeks added a large sharp *ram* (point) to the prow at the water line to use in battle. About 700 B.C., the Greeks built some galleys with two *banks* (rows) of oarsmen on each side, one above the other. The two-banked galleys had much more speed and ramming power than vessels with one bank of oarsmen had. About 650 B.C., the Greeks invented the *trireme*. It had three banks of rowers on each side, one above the other.

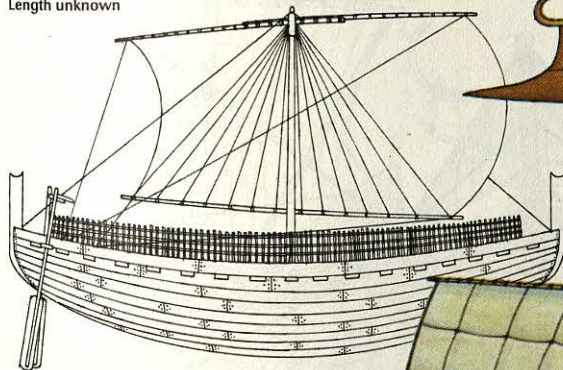
The Greeks—and later the Romans—built the hull of their ships first, as the Egyptians had done. But they used more and tighter joints to fit the planks together. They also inserted a system of ribs to stiffen the hull. As a result, Greek and Roman ships had strong hulls.

Phoenician and Greek ships

The Phoenicians left no records of how their ships looked. The little that scholars know about these vessels comes from other ancient peoples. The Greeks, however, pictured their ships on pottery. The Phoenicians and Greeks built broad, roomy cargo ships and long, narrow war galleys. The Greeks added a ram to the galley's prow between 1000 and 800 B.C. About 650 B.C., they invented the greatest warship of ancient times, a three-banked galley called a *trireme*.

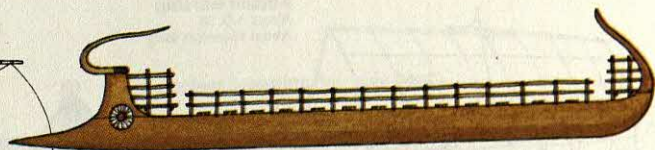
Phoenician cargo ship

About 1400 B.C.
Length unknown



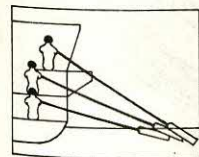
Greek galley

About 700 B.C.
About 23 metres long

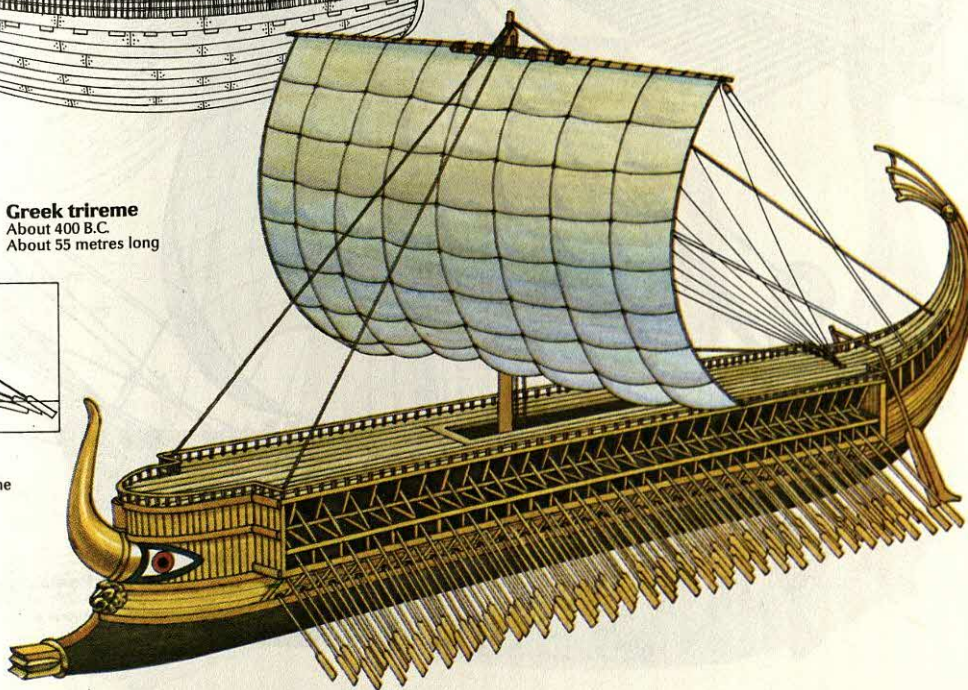


Greek trireme

About 400 B.C.
About 55 metres long



How rowers were arranged in a trireme



Roman ships. The Romans became rulers of the Mediterranean region during the 100's B.C. They used chiefly the same kinds of ships the Greeks had used.

The Romans built up the largest merchant fleet of ancient times. Their biggest cargo ships carried grain from Alexandria, Egypt, to Rome. The largest ones measured up to 55 metres long and 14 metres wide. They could carry more than 910 metric tons of cargo and as many as 1,000 passengers.

Roman cargo ships, like all freighters of ancient times, carried travellers because no ships were designed only for passengers. Travellers simply reserved space on any freighter going their way. The ships had a few cabins for important people. The other passengers lived on the open deck. These people slept under little shelters that they set up each night.

Viking ships were the best vessels built in northern Europe between the A.D. 700's and the late 1000's. The bold Vikings sailed their famous *long ships* across the North Atlantic Ocean to Greenland and even to North

America. They raided, traded, and colonized. As pirates, they were the terror of the seas.

We know much about the superb Viking ships because many Viking lords arranged to be buried in their boats. Scientists have found several such tombs. A well-preserved example of a Viking warship was uncovered in 1880 near Gokstad, in southeastern Norway. The Vikings built the ship about A.D. 900. It measures 24 metres long and 5 metres wide. Like all Viking ships, the hull is *clinker-built*—that is, the planks overlap. The ship carried 16 oarsmen on each side. It had a square sail mounted on a mast probably 12 metres high and a steering oar near the stern. The Gokstad ship was relatively small. Most Viking long ships had 20 oars on each side, and some had 30. See **Vikings** (Shipbuilding and navigation).

In 1893, a group of Norwegians built a full-scale replica of the Gokstad ship. They sailed it across the Atlantic Ocean from Bergen, Norway, to St. John's, Newfoundland, in only 28 days in spite of bad weather.

Roman ships

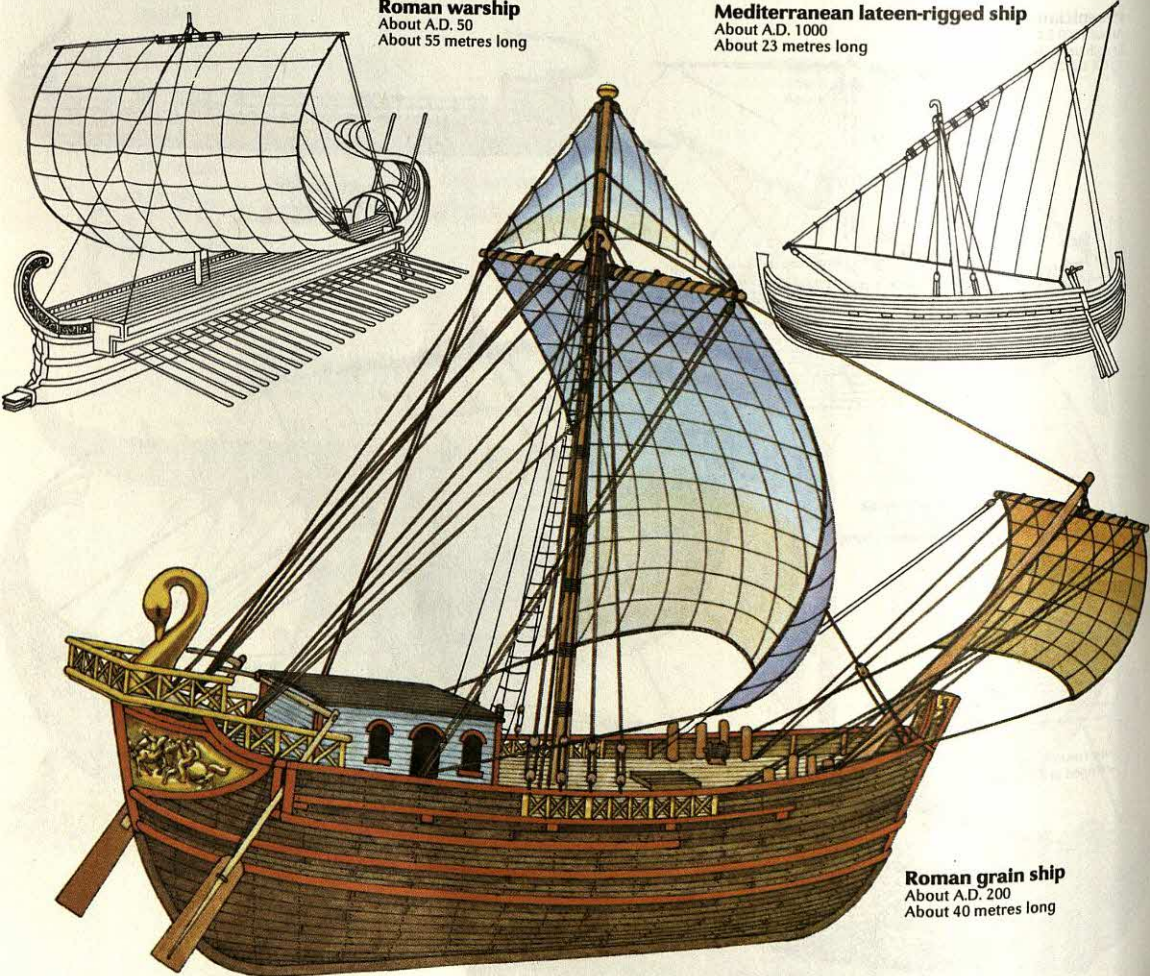
The Romans mainly used warships and cargo vessels similar to those that the Greeks had used. But they also had a big, single-banked warship. The Romans built the largest merchant fleet of ancient times. Their biggest cargo ships brought grain from Egypt. The Romans, like the Greeks, used triangular sails called *lateens* on their smaller craft. The big freighters carried square sails. Widespread use of the lateen began in the Mediterranean area during the Middle Ages.

Roman warship

About A.D. 50
About 55 metres long

Mediterranean lateen-rigged ship

About A.D. 1000
About 23 metres long



Roman grain ship

About A.D. 200
About 40 metres long

The cog. The power of the Vikings gradually declined. By the late 1000's, they had lost control of the northern seas. Trade then began to increase among the countries of northern Europe. Merchants needed roomier vessels to carry larger shipments. By about 1200, shipbuilders in the north had developed a sturdy ship called the *cog*. It became the standard merchant vessel and warship of northern Europe for about 200 years.

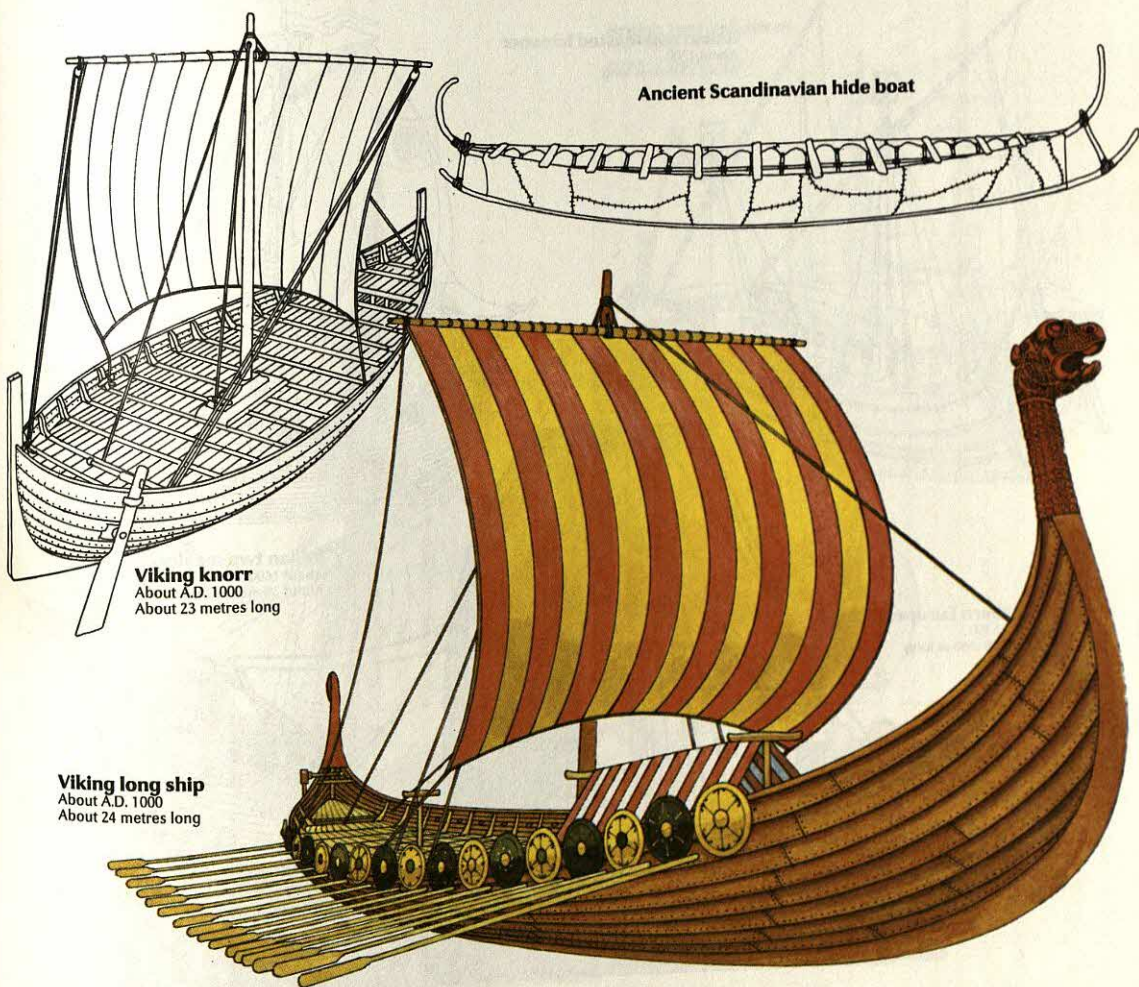
Cogs could stand up against the rough seas and high winds of the North Sea and North Atlantic Ocean. Their deep, wide clinker-built hulls held bulky cargoes. Cogs had one large square sail. They also had a structure called a *castle* at the prow and the stern. The *forecastle*, at the prow, served as a platform from which soldiers could fire arrows and stones at enemy ships. The *stern-castle* provided a shelter for important passengers. Cogs also had a new kind of steering apparatus. Instead of steering oars along the sides near the stern, cogs had a large *rudder* in the middle of the stern. This rudder, introduced by about 1200, was stronger than oars.

Lateen-rigged ships. While northern shipbuilders were developing the cog, Mediterranean shipbuilders were also making important changes in ship construction and design. The Mediterranean shipbuilders began a new way of shipbuilding that became standard. They built a skeleton of keel and ribs first and then fastened the planks of the hull to the framework. They also greatly increased the use of triangular sails called *lateens*. Square sails worked well with winds blowing from behind. But unlike lateen sails, they did not work well when the ship was sailing into the wind.

Galleys had always been used in the Mediterranean region as cargo and passenger ships as well as warships. But about 1300, the use of cargo and merchant galleys increased greatly. These galleys generally used their oars only when there was no wind and when entering or leaving a harbour. The rest of the time the vessels were driven by lateen sails. Most galleys had two masts, with the forward mast carrying the large sail. Some had three masts. The merchant galleys were

Viking ships

The people of Scandinavia have a long tradition as seafarers. In ancient times, they built dugouts, hide boats, and boats of wooden planks. From these early craft developed the Viking ships—the best ships built in northern Europe between the A.D. 700's and the late 1000's. The Vikings built broad, roomy cargo ships called *knorrs*. But they are best known for their *long ships*. They sailed these swift, narrow vessels across the unknown waters of the Atlantic Ocean to North America.



Ancient Scandinavian hide boat

Viking knorr
About A.D. 1000
About 23 metres long

Viking long ship
About A.D. 1000
About 24 metres long

longer and wider than the warships. The standard galley could carry about 127 metric tons.

The full-rigged ship. About the mid-1400's, Mediterranean shipbuilders combined the best features of the sturdy cog with those of their own lighter lateen-rigged vessels. The result was a sailing ship that became standard throughout Europe for about 300 years. The Mediterranean shipbuilders continued to build the hull by fastening the planking to a skeleton of keel and ribs. But they replaced the steering oars with a rudder in the stern. They also adopted the forecastle and sterncastle of the cog. Most important, they changed the rig to gain more power and better steering—and so developed the full-rigged ship.

The basic full-rigged ship, or *square-rigger*, had a *mainmast* in the middle of the ship, a *foremast* in the forward part, and a *mizzenmast* in the back part. The mainmast and foremast each carried a big square sail and, above it, smaller square sails. The mizzenmast held a lateen sail. A pole that stuck out from the bow carried

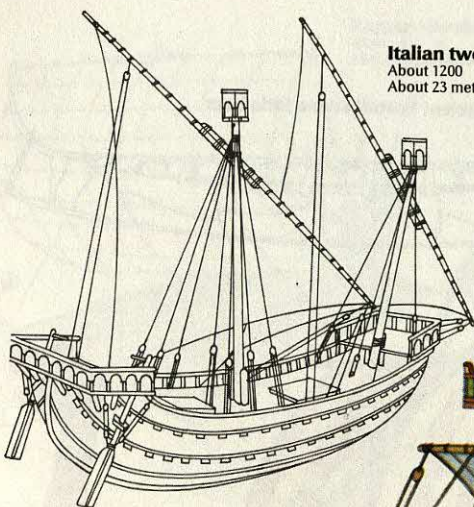
a small square sail. During the late 1400's and 1500's, such great explorers as Christopher Columbus, Vasco da Gama, Sir Francis Drake, and Ferdinand Magellan used ships rigged in this way.

The galleon. About the mid-1500's, a type of sailing ship called the *galleon* appeared on the seas. Galleons were big vessels with lower forecastles than other ships and a high sterncastle that housed more roomy living quarters. The foremast and mainmast each carried two or three sails, and the mizzenmast carried one or two. On the biggest galleons, a second mizzenmast was added near the stern.

Galleons served as both warships and cargo vessels. Guns had been used aboard ships since about the mid-1300's. But the galleons carried more and heavier guns. In 1588, the English and Spanish fleets fought one of the most famous sea battles in history. Both sides used galleons. But the English galleons were faster, more manoeuvrable, and better armed. They helped defeat the Spanish fleet. The Spaniards had called their fleet

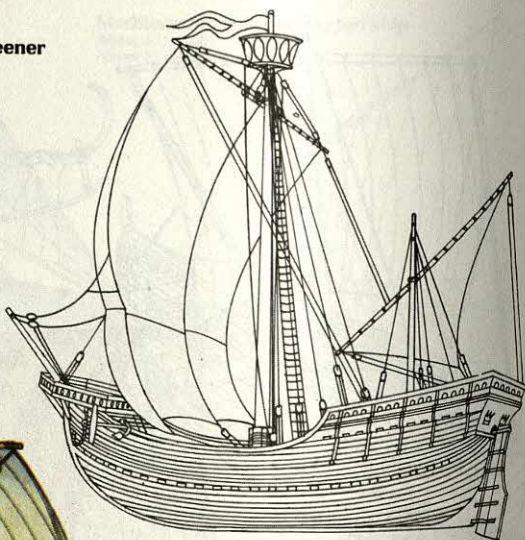
Ships of the 1200's to the 1500's

By about 1200, shipbuilders of northern Europe had developed the *cog*—a one-masted ship with a square sail and high castles at the prow and stern. By about 1200, they invented the rudder. Meanwhile, Mediterranean shipbuilders had increased the use of lateen sails on all their craft, from small boats with one mast to big freighters with three masts. During the 1400's, they combined the best features of the cog and lateener, producing two-masted and, finally, three-masted *carracks*.



Italian two-masted lateener

About 1200
About 23 metres long

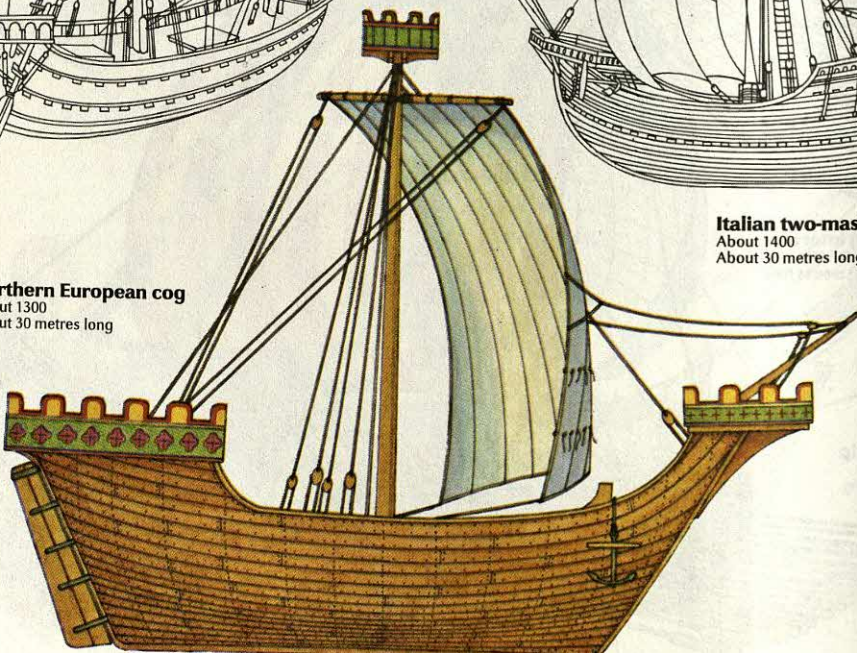


Italian two-masted carrack

About 1400
About 30 metres long

Northern European cog

About 1300
About 30 metres long



the *Invincible Armada* because they thought it could not be defeated (see **Spanish Armada**).

Spain, Portugal, and other countries also used galleons for trading. Spain used them to bring back gold and silver from its possessions in the New World. These treasure ships became a favourite target of pirates who roved the Caribbean Sea.

Junks and dhows were sturdy wooden sailing ships widely used in the East, and still seen in Eastern waters. The junk was used by the Chinese and Japanese. Its square sails were made of bamboo slats, like a venetian blind. There were small river junks and large oceangoing junks more than 30 metres long. Dhows were used by Arab and Indian seamen. These craft had a single mast with a lateen sail, Dhows traded between India, Africa, and Arabia. Other Eastern sailing craft include the patile, an Indian vessel used on the River Ganges, and the two-masted Malayan prau, about 15 metres long.

East Indiamen. For centuries, ships had served as both cargo vessels and warships. But by about the

1600's, cannons had become so heavy that ships needed specially built hulls to carry the added weight. The design of warships and unarmed cargo vessels thus became, in time, greatly different.

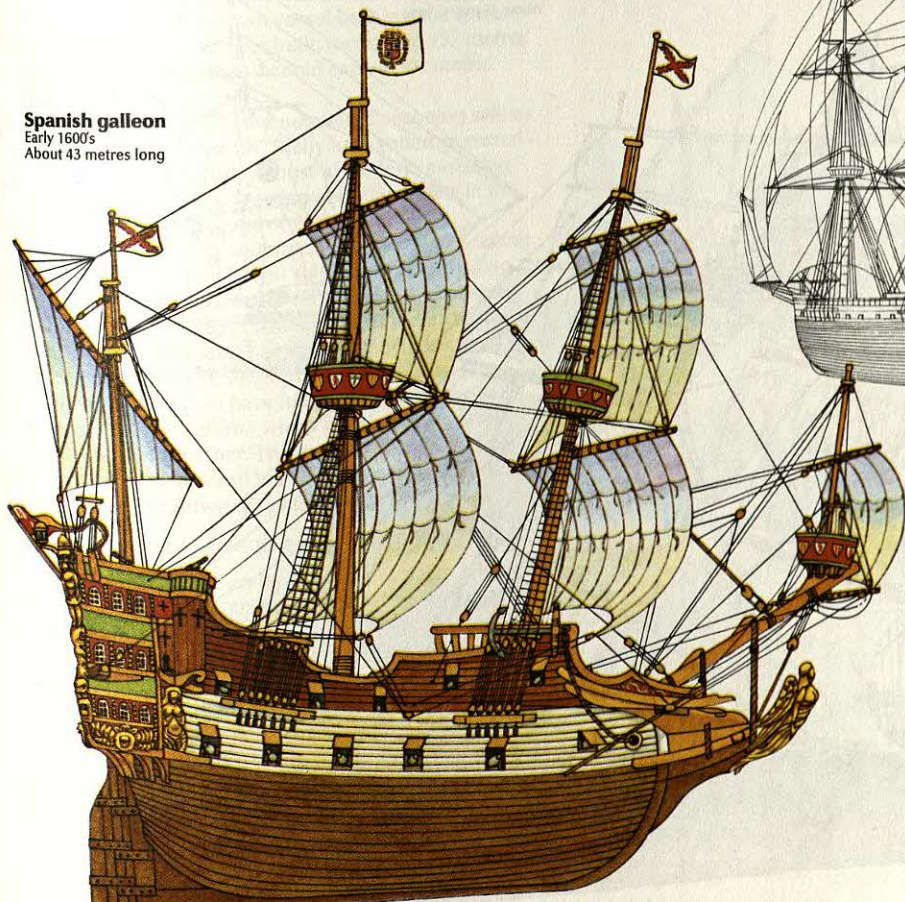
In the 1600's, trading companies in several European countries began to build merchant ships especially for trade with India and the Far East. These ships brought ivory, silks, spices, and other products from India, China, and the East Indies. The Portuguese controlled the trade with the Far East until about 1600, when England and the Netherlands began to compete. Then Denmark and France also moved in. East India companies in each country built their own ships, called *East Indiamen*. Although the Indiamen were designed as cargo carriers, they carried guns for defence against attacks by pirates and fleets of enemy countries.

The size of the East Indiamen grew steadily larger. In 1700, for example, most English Indiamen carried 360 metric tons of cargo. By 1800, they carried 1,090 metric tons.

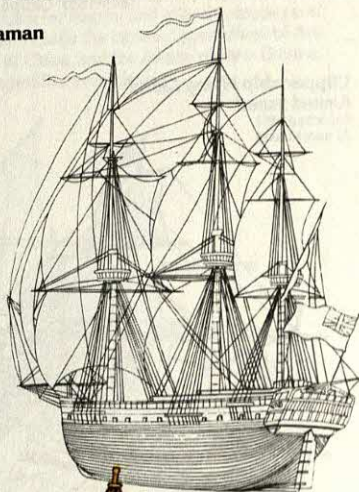
Ships of the 1500's to the 1800's

Galleons appeared on the seas about the mid-1500's. These big ships had high sterncastles and two or three sails on the foremast and mainmast and one or two sails on the mizzenmast. Galleons served as both warships and merchant ships. During the 1600's, European trading companies began to build large ships called *East Indiamen* for the rich trade with India and the Far East. These ships carried guns for defence against attacks by pirates and fleets of enemy countries.

Spanish galleon
Early 1600's
About 43 metres long



British East Indian
Late 1700's
About 52 metres long



Packet ships. By the early 1800's, trade across the Atlantic between the United States and Europe had increased tremendously. Also, a great demand had developed for better transatlantic passenger service. Ship-owners met the demand by offering something new in service—ships that sailed on regular schedules. Such vessels are called *packet* ships. Before this time, ships sailed only if they had a full load of cargo and passengers. Also, the weather generally had to be favourable. Packet ships sailed at a scheduled time, fully loaded or not and regardless of the weather. The packets also became the first merchant vessels to stress the comfort of passengers. Packet service began in 1818, between New York City and Liverpool.

To meet the schedules and the competition, the packet ships had to sail as fast as possible. But the ships themselves were ordinary sailing vessels that had not been designed with especially sharp lines for speed. Their captains drove the ships furiously night and day in all weather. The eastward Atlantic crossing took from

three to four weeks. The westward crossing took longer—from five to six weeks—because the ships had to sail against the westerly winds and took a longer, more southerly route.

The first packets measured about 30 metres long. By the 1840's, as passenger accommodations became larger and more comfortable, ships 49 metres long had come into use.

Clipper ships, the most beautiful and romantic of all sailing ships, became the queens of the seas during the mid-1800's. The clippers, with their slender hulls and many sails, were designed for speed. Their name came from the way the ships "clipped off" the miles.

The United States built the first true clippers in the 1840's. They were designed to sail from the East Coast, around the tip of South America, to China and bring back tea. The discovery of gold in California in 1848 and in Australia in 1851 hastened the clipper's development as fortune seekers and supplies were rushed to the gold fields. The British built clippers to carry tea from China

Ships of the 1800's

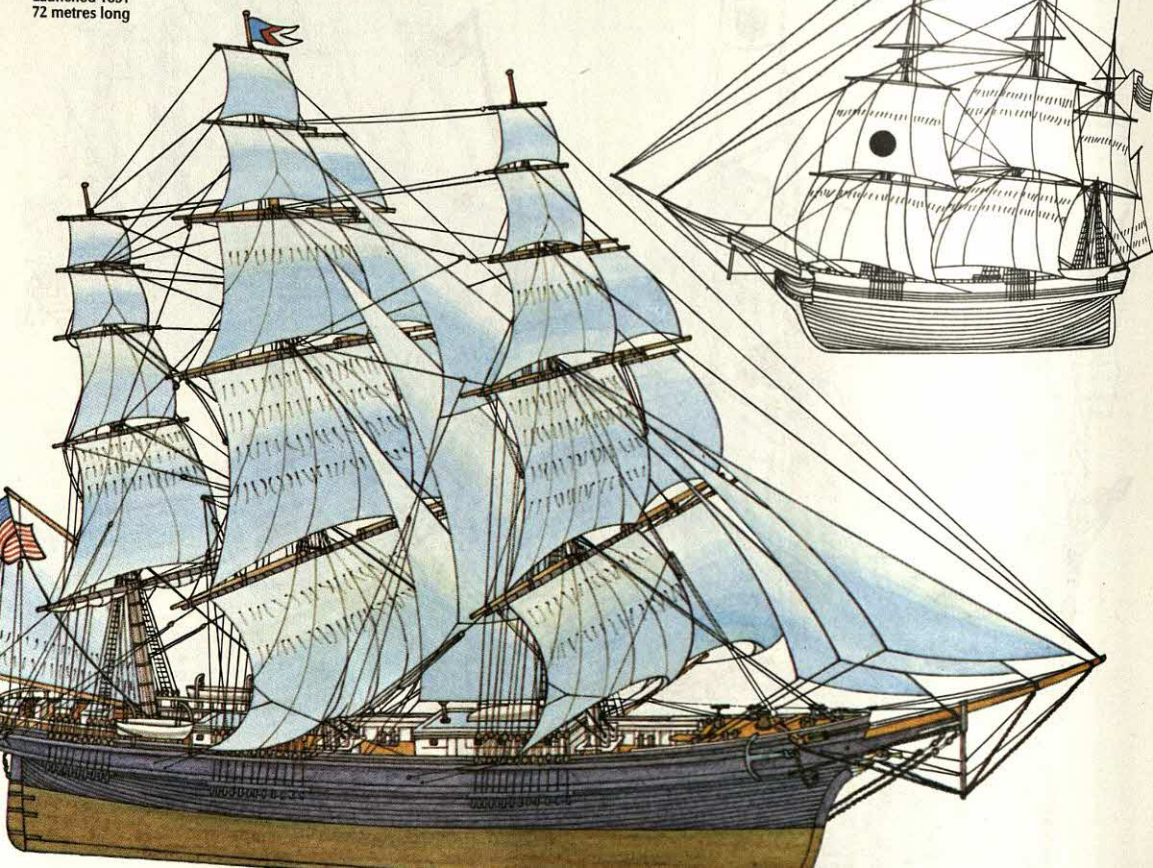
The most famous ships of the 1800's included the *packets* and *clippers*. Packet ships began to cross the Atlantic Ocean in 1818. They made regular voyages whether or not they were fully loaded. Clipper ships appeared during the 1840's. They brought tea from China and wool from Australia and carried passengers around Cape Horn to California, U.S.A. during the gold rush of 1849-1857. Clippers, with their many sails and slender hulls, could speed through the water.

Clipper ship *Flying Cloud*

(United States)
Launched 1851
72 metres long

Packet ship *Europe*

(United States)
Launched 1833
About 42 metres long



and wool from Australia. A famous British clipper, the *Cutty Sark*, is now preserved at Greenwich in London.

Clippers had as many as six *tiers* (rows) of sails to a mast. Some ships had as many as 35 sails. Driven at top speed, clippers could cut through the water at 20 knots (37 kilometres per hour). The clipper *Thermopylae* sailed from London to Melbourne in 60 days.

Donald McKay, a Canadian based in the United States, became the greatest designer of clipper ships. McKay's first clippers measured about 60 metres long and could carry 1,360 metric tons. In 1853, he launched the *Great Republic*, which was the largest sailing ship of its time. It was about 102 metres long, had four masts, and could carry more than 4,080 metric tons.

Sailing ships in the 1900's. Inventors began experimenting with steam-powered boats in the late 1700's. By the early 1900's, the steamship had nearly replaced the oceangoing sailing ship. But coal-burning steamships had to depend on coaling depots, and certain trade routes—such as those along the coasts of South America—had few coaling depots. On these routes, sailing ships still had use. For many years, for example, sailing ships carried *nitrate*, a fertilizer, from Chile, around the tip of South America, to Europe.

The sailing ships launched during the late 1800's and early 1900's were huge vessels built more for strength than speed. They had strong, straight-sided steel hulls and wire rigging. To operate cheaply, they used small crews and, therefore, carried a minimum amount of sail. The mightiest of these ships was the *Preussen*, a five-masted, full-rigged German vessel built in 1902. It was the largest sailing ship ever built, measuring 132 metres long and 16 metres wide. It could carry 7,300 metric tons of cargo.

Since the early 1900's, the number of seagoing sailing ships has declined steadily. Many have rotted or rusted away at their docks. Today, most of the few remaining square-riggers serve as training ships for cadets in the navies and merchant fleets of various countries.

In many developing countries, people still use sailing vessels for coastal and inland shipping and for fishing. The Chinese still use junks to carry goods and passengers along coasts and on rivers. Various Indian versions of the Arab dhow can still be seen in the harbours of Bombay, Calcutta, and other port cities of India. The people of New Guinea have long used a primitive sailing vessel called a *lakatoi*, which consists of several dugouts lashed together. Two-masted *schooners* and single-masted *sloops* sail between Panama and Ecuador and along South America's west coast.

The age of engine-powered ships

The invention and development of the steam engine revolutionized water transportation. People no longer had to depend on the muscles of rowers or the uncertain wind to propel their ships. In 1769, James Watt, a Scottish engineer, patented a steam engine that could do many kinds of work. Inventors in Europe and the United States soon tried to use it to power boats.

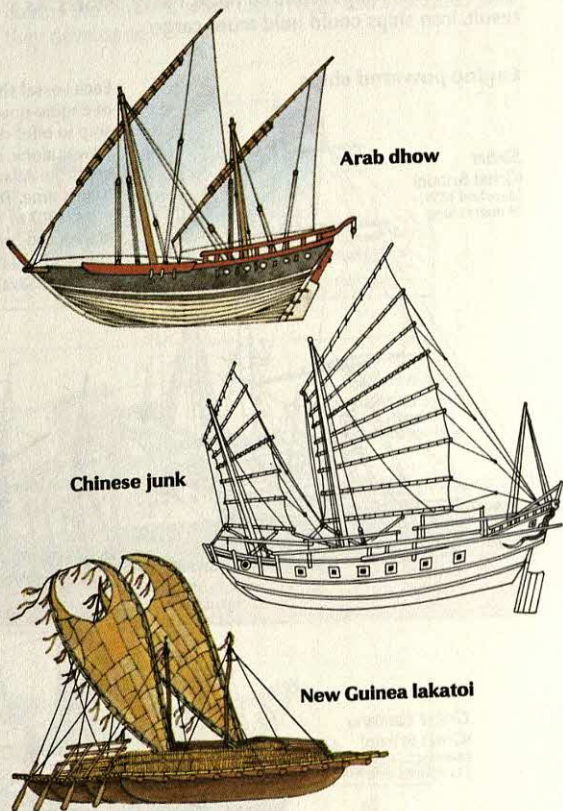
The first steamboats. In 1783, the Marquis Claude de Jouffroy d'Abbans, a French nobleman, built a steamboat that made a 15-minute trip on the Saône River near

Lyon. But the marquis was never able to repeat his success. In 1787, John Fitch, an American inventor, demonstrated the first workable steamboat in the United States. Its engine powered a series of paddles on each side of the boat. Fitch later developed a vessel pushed by paddles at the stern. With this boat, he started a commercial passenger and freight service during the summer of 1790. He navigated the boat on schedule up and down the Delaware River between the cities of Philadelphia, and Trenton. But Fitch lacked enough money to keep operating. In 1802, William Symington, a British engineer, built a steam tug that had a paddle wheel at the stern. The tug worked perfectly, but Symington also ran out of money.

The *Clermont* became the first commercially successful steamboat. Robert Fulton, an American, designed and built the vessel, which was officially called the *North River Steam Boat*. Fulton did not try to construct an engine himself, as earlier inventors had done. Instead, he ordered one from Watt and adapted it to his boat. In 1807, the *Clermont* steamed 241 kilometres up the Hudson River from New York City to Albany in about 30 hours, including an overnight stop. After extensive

Sailing ships of the East

Few seagoing sailing ships are used today. But especially in the East, people still use them for coastal and inland shipping and for fishing. These ships include the lateen-rigged *dhow* of Arabia, the wooden *junk* of China, and the *lakatoi* of New Guinea, known for its sails shaped like crab claws.



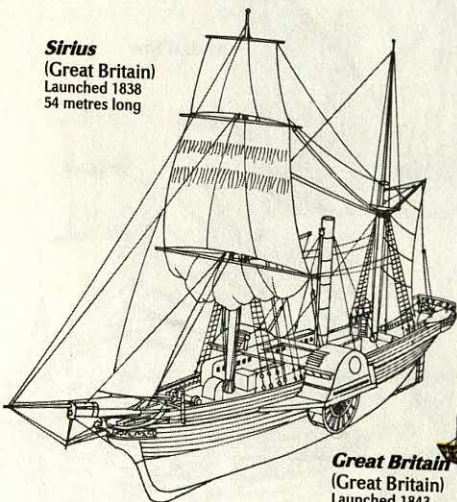
rebuilding, the boat maintained passenger service on the Hudson. The *Clermont* was long and slender—originally 43 metres long and 4.0 metres wide. It had side paddle wheels 1 metre wide and 4.5 metres in diameter. After the rebuilding, the *Clermont* was 45 metres long and 5 metres wide.

Oceangoing steamships. Fulton's boats puffed along only on bays and rivers. In 1809, the *Phoenix* became the first steamboat to make an ocean voyage. It travelled along the Atlantic coast and up the Delaware River from New York City to Philadelphia. The trip took 13 days. Under perfect conditions, sailing boats could do it in 2 days. In 1819, an American vessel, the *Savannah*, became the first steamship to cross the Atlantic Ocean. It was actually a full-rigged sailing ship equipped with steam-powered side paddle wheels. The ship took 29 days to travel from New York City to Liverpool. During the voyage, it ran its engine for 80 to 105 hours, using up its entire fuel supply of 68 metric tons of coal and 91 cubic metres of wood. In 1838, the British side-wheeler *Sirius* became the first ship to offer regularly scheduled service across the Atlantic under steam power alone. The trip took 18½ days.

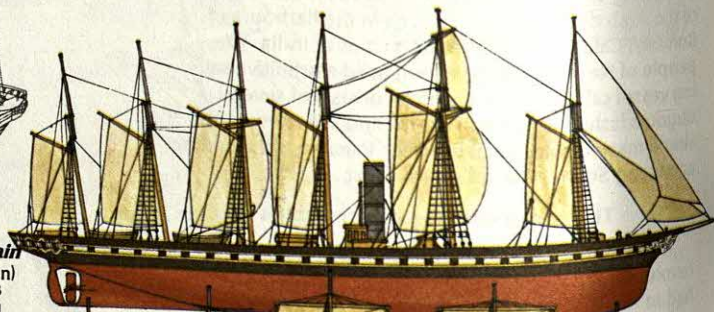
Ships of iron. During the late 1700's, British shipbuilders had begun to construct iron vessels, partly because good wood for ships was becoming scarce in Great Britain. But iron ships also had many advantages over wooden ones. They were stronger, safer, more economical, and easier to repair. In addition, iron ships were lighter than wooden ships of the same size, because wooden ships required huge, heavy timbers. As a result, iron ships could hold more cargo.

Engine-powered ships

Sirius
(Great Britain)
Launched 1838
54 metres long



Great Britain
(Great Britain)
Launched 1843
98 metres long



Great Eastern
(Great Britain)
Launched 1858
211 metres long



Great Britain led the world in the development of iron seagoing ships. In 1821, it launched the *Aaron Manby*, probably the first all-iron steamship. Britain's most gifted naval architect of the mid-1800's was Isambard Kingdom Brunel. In 1837, he launched the *Great Western*, the first steamship designed especially for regular Atlantic crossings. The *Great Western* measured 72 metres long and 11 metres wide. Its huge side wheels drove the vessel at 9 knots. Brunel designed ever-larger ships. In 1858, he completed the *Great Eastern*, the most spectacular ship built to that time. It was 211 metres long and about 26 metres wide and accommodated 4,000 passengers. It had paddles, screws, and sails. But the ship failed economically. It did not attract enough customers to pay the huge operating costs. The *Great Eastern* was used in laying four successful transatlantic telegraph cables across the ocean floor. In 1888, the ship was sold for scrap.

During the late 1800's, steel began to replace iron for ships. Steel ships were stronger and lighter than iron ones. In 1881, the *Servia*, a British vessel, became the first all-steel passenger liner to cross the Atlantic.

Development of the screw propeller. In 1836, two inventors—Francis Pettit Smith of England and John Ericsson of Sweden—each patented a screw propeller that could drive steamboats more efficiently than paddle wheels could. The side paddles had worked well in calm waters. But in rough seas, as a ship rocked from side to side, one wheel and then the other might stick completely out of the water, wasting power. In addition, waves easily damaged the fragile wheels. A screw propeller, wholly under the water at the stern, used power

Each vessel shown below and on the next page made history in the development of engine-powered ships. In 1838, the *Sirius*, a side-wheeler, became the first ship to offer regularly scheduled service across the Atlantic Ocean under steam power alone. In 1845, the *Great Britain* became the first propeller-driven ship to cross the Atlantic. The *Great Eastern*, launched in 1858, was the largest ship built to that time. The turbine-powered *Mauretania* was one of the first modern liners. From 1907 to 1929, it held the Blue Ribbon of the Atlantic for crossing the ocean at a record-breaking average speed of 27 knots. The *United States* had a cruising speed of 33 knots and was the fastest ship afloat until it was retired in 1969. In 1959, the *Savannah* became the world's first nuclear-powered merchant ship.

more efficiently than the paddle wheels did. As the propeller bit into the water, it also pushed the ship forward much faster. In 1845, the *Great Britain*, designed by Brunel, became the first propeller-driven ship to travel across the Atlantic.

Increasing power and speed. New types of engines and new sources of power were developed as ships changed from wood to steel and from paddle wheels to propellers. Until the middle to late 1800's, ships used a one-cylinder steam engine. The steam expanded in the cylinder, drove the piston a full stroke, and then passed to a condenser, where it was converted back to water. By the late 1800's, the *compound* steam engine, which had two cylinders, began to be used on ships. In the compound engine, steam pushed the piston in one cylinder and then passed on to a second, larger cylinder. The engine thus created much more power from the same amount of steam. The compound steam engine cut the use of coal on ships up to 50 per cent. Later, shipbuilders installed three-, four-, and five-cylinder steam engines on their ships.

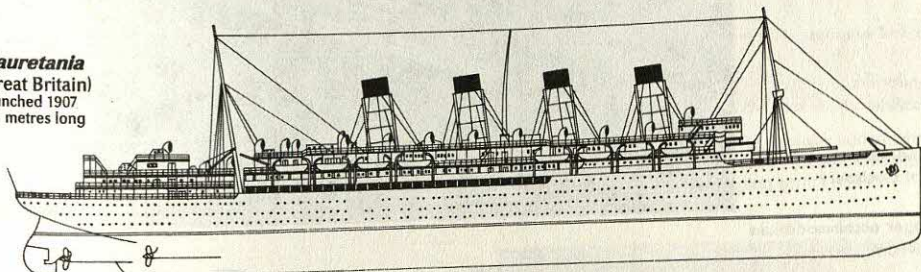
In the 1890's, Charles A. Parsons, an English engineer, designed a marine *steam turbine*, a completely new type of marine engine. It was much more powerful and efficient than the steam engine. In 1897, Parsons installed three turbines in his vessel, the *Turbinia*. The turbines powered the vessel at an amazing $34\frac{1}{2}$ knots. Within a few years, fast luxury liners began crossing the Atlantic Ocean powered by steam turbines. One of the most famous of these liners was the British ship *Mauretania*, launched in 1907. It was 241 metres long and had a speed of 27 knots.

While Parsons was working on his steam turbine during the 1890's, Rudolf Diesel, a German mechanical engineer, was perfecting another new type of engine. It used heavy oil as fuel. His engine, now called the *diesel engine*, used less fuel than the turbine and required much less space on a ship. In 1910 and 1911, the first diesel-powered ships, which are called *motorships*, went into operation. Beginning about 1920, oil also began to replace coal as fuel for steam turbines. Today, most steamships use oil.

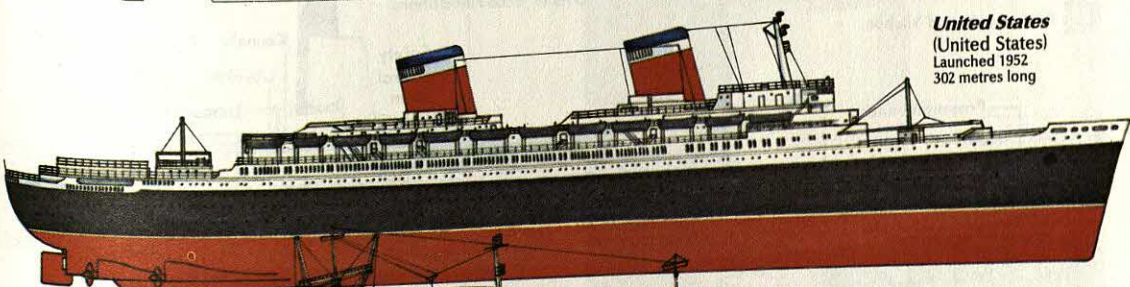
Nuclear power and automation. In 1954, the United States launched the world's first nuclear-powered ship, the submarine *Nautilus*. It was retired in 1979. The former Soviet Union built the first surface ship driven by nuclear power, the icebreaker *Lenin*. It was built in Leningrad (now St. Petersburg) and was first put into service in 1959. It is the world's largest icebreaker. In 1959, the U.S. launched the *Savannah*, the first nuclear-powered merchant ship. It was retired in 1971. After the 1950's, Germany, Japan, and the Soviet Union also built nuclear-powered merchant ships. But nuclear merchant vessels are still impractical for commercial use because of their high building and operating costs.

Ships today have become increasingly automated. On many modern vessels, for example, electronic equipment controls the flow of fuel oil and air to the furnace and of water to the boilers. Automatic navigation aids help keep ships on course. Ships have also become larger and larger, and entirely new types of vessels have been developed. The next section of this article discusses the kinds of ships used today and describes how they developed.

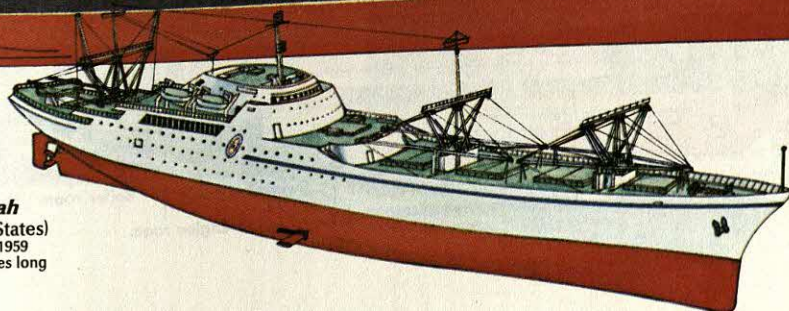
Mauretania
(Great Britain)
Launched 1907
241 metres long



United States
(United States)
Launched 1952
302 metres long



Savannah
(United States)
Launched 1959
181.5 metres long



Until the late 1940's, the queens of the sea were the great oceangoing passenger liners. France, Germany, and Great Britain built most of these magnificent floating hotels. The liners stressed luxury and service. In addition to the regular deck and engine room hands, an army of cabin and dining room stewards, cooks and bakers, and other service workers staffed the liners.

Beginning in the late 1940's, aeroplanes began to carry more and more people across the seas. Today, relatively few passenger liners sail the oceans, and the great cargo ships have become the queens of the sea. These ships emphasize efficiency and economy.

Cargo vessels have become bigger and bigger,

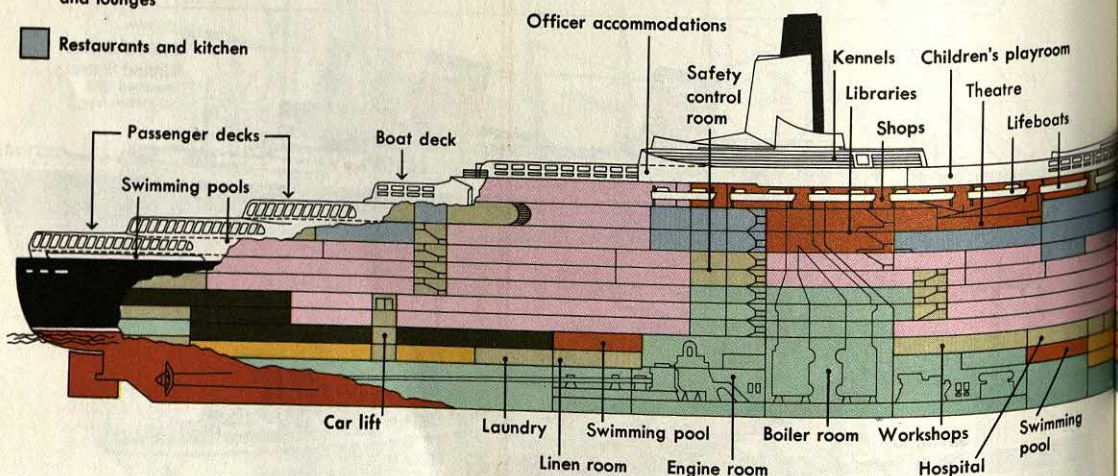
chiefly for economic reasons. For example, shippers have found it far cheaper to transport 91,000 metric tons of oil in one huge tanker than in five smaller ones carrying 18,000 metric tons each. Also, for economic reasons, shipbuilders have designed vessels that can be loaded and unloaded in a minimum amount of time with minimum labour. In addition, more and more cargo ships are being automated so they can be run by smaller and smaller crews.

Passenger vessels

The sailing packets that began to cross the Atlantic Ocean in the early 1800's were the first ships to stress

The Queen Elizabeth 2

The *Queen Elizabeth 2* is one of the largest and most modern passenger ships. The British liner is 294 metres long. It was launched in 1967 and made its maiden voyage in 1969. It can carry over 1,700 passengers and has a crew of 1,000. The ship has a cruising speed of $32\frac{1}{2}$ knots. The *QE2* makes transatlantic crossings and it carries tourists on a cruise around the world. The diagram below shows a cross section of the ship.



passenger comfort. From then on, shipping companies provided better and better passenger services. As ships switched from sails to steam power during the 1800's, British companies offered the best passenger accommodation, largely because of Brunel's excellently designed ships.

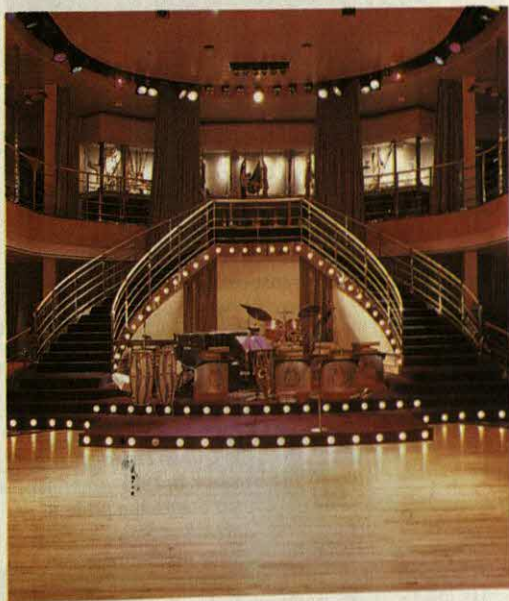
Two British firms—the Cunard Line and the White Star Line—dominated transatlantic service until about 1900. Then, Germany's North German Lloyd Line and Hamburg American Line began to offer serious competition. Later, French and Dutch lines entered the race for transatlantic passenger business. Much of this business came from transporting immigrants from the Old World to the

New World. The United States took the lead in providing service across the Pacific Ocean with the founding of the Pacific Mail Steamship Company in 1848. As various shipping lines competed for passengers, ships became larger, faster, and more luxurious.

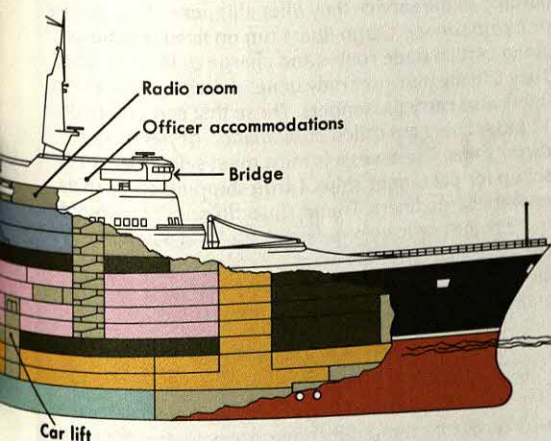
Ocean liners. The great age of the ocean liner came in the early 1900's. It reached its height in the 1930's with the launching of three of the most luxurious ships ever built. They were the *Normandie* of France and the *Queen Mary* and *Queen Elizabeth* of Britain. These giants, each almost 300 metres long, crossed the Atlantic Ocean in just over four days. In 1942, a fire destroyed the *Normandie* as it lay in New York Harbor.



The elegant *Queen's Grill* is one of four gourmet restaurants on the *QE2*. World-class chefs and a staff of over 200 waiters and about 140 kitchen personnel serve the dining rooms.



The *Grand Lounge* is one of the features added when the *QE2* was renovated in 1986 and 1987. The lounge includes a dance floor, a bandstand, and a shopping promenade.



Passenger accommodation on the *QE2* consist of standard-class rooms, deluxe-class rooms, above, and luxury suites. All rooms are air-conditioned.



Air cushion vehicles ride on air just above the water's surface. They move rapidly over short distances. The Canadian Coast Guard uses these craft as rescue vehicles, *above*.

Beginning in the late 1940's, the aeroplane began to attract more and more transoceanic passengers. Today, jet planes fly daily between the world's great cities. They cross the sea in hours, not days, and at about half the cost of an ocean trip. Ocean liners cannot compete with the aeroplane for speed. During the 1960's, Britain sold the *Queen Mary* and *Queen Elizabeth* to American investors who planned to make tourist attractions of the ships. In 1972, fire destroyed the *Queen Elizabeth* as it lay at anchor in Hong Kong harbour. In 1951, American shipbuilders launched the *United States*, the pride of the nation's passenger fleet. The *United States* had a cruising speed of 33 knots and was the fastest ocean liner afloat. But in 1969, the ship stopped operating because of a lack of passengers. Today, there are no major year-round passenger liner services across the Atlantic.

The only luxury liner that still makes transatlantic crossings is Britain's *Queen Elizabeth 2*, which was launched in 1967. It crosses the Atlantic from April until December and it carries passengers on a cruise around the world during the winter months. Most liners today are used as cruise ships to the Mediterranean, the Caribbean, and other holiday areas. Norway's *Sovereign of the Seas*, a cruise ship which began service in the Caribbean in 1988, can carry more passengers than any other ship. The *Sovereign* can carry almost 2,700 passengers and 750 crew members.

Other passenger vessels. Although the aeroplane has largely replaced the ocean liner for transoceanic travel, vessels for carrying passengers short distances over water have become increasingly important. Such short-distance vessels include car ferries, hydrofoils, and hovercrafts.

Car ferries have carried cars, passengers, and railway carriages across harbours, lakes, rivers, and other small bodies of water for many years. Like cargo ships, ferries have become bigger and bigger. Today, the biggest ones cross such large bodies of water as the Adriatic

and Baltic seas and the English Channel. The largest car ferries can hold up to 800 passengers and 360 cars. They have dining rooms, lounges, and bars. Some ferries make overnight runs and have cabins for most passengers.

Hydrofoils provide high-speed transportation over relatively short distances. These vessels are mounted on foils (wings that skim near the surface of the water). The hull remains completely out of the water, greatly reducing the drag caused by water resistance. Hydrofoils can reach speeds greater than 80 knots. These vessels have carried passengers across the English Channel, on the Nile River of Egypt, across the Strait of Messina in Italy, and over other bodies of water in many parts of the world.

Hovercrafts also provide fast trips for short distances. Hovercrafts have a powerful horizontal fan that produces a strong, continuous thrust of air between the vehicle and the water or ground beneath it. The craft, which is driven by aeroplane-style propellers, rides on this cushion of air and can do almost 70 knots. Hovercrafts are especially popular in Great Britain, where they have carried passengers on the River Thames and along the coasts, and are used to operate a regular ferry service for passengers and vehicles across the English Channel to France.

Classification of cargo ships

Cargo ships, or freighters, can be divided into four groups, according to the kind of cargo they carry. These groups are (1) general cargo ships, (2) tankers, (3) dry bulk carriers, and (4) multipurpose ships. *General cargo ships* carry what are called "packaged" items—goods that are put in packages or that form a package in themselves. Packaged items include such products as chemicals, foods, furniture, machinery, motor vehicles, shoes, steel, textiles, and wine. *Tankers* carry petroleum or other liquid cargo. *Dry bulk carriers* carry coal, grain, iron ore, and similar products that can be loaded in *bulk* (loose) on the vessels. *Multipurpose ships* carry different classes of cargo—for example, liquid and general cargo—at the same time.

Cargo ships can also be divided into two types according to the service they offer shippers—*liner service* or *tramp service*. Cargo liners run on fixed schedules along certain trade routes and charge published rates. They usually transport only general cargo. Some cargo liners also carry passengers. Those that carry more than 12 passengers are called *combination or passenger-cargo ships*. These vessels must meet safety standards set up for passenger ships. Large shipping companies operate cargo liners. Tramp ships do not sail on regular trade routes or have regular schedules. They wander the sea lanes like taxicabs and can be hired to haul almost anything, anywhere, anytime. Small shipping companies and private individuals operate these ships.

General cargo ships

During the early 1900's, the standard general cargo ship was a *three-island* ship. Its name came from three structures that stood out above the main deck like separate islands. The forecastle, which held the crew's quar-

ters, formed one island at the bow. The bridge, from which the ship was navigated, formed the second island in the middle of the ship. The engine room was below the bridge. The poop, which held cabins for the officers and passengers, formed the third island at the stern. Hatches between the islands led to the holds beneath the deck where the cargo was stored. Each hold was a separate area with a hatch cover over it. The *derricks* (lifting devices) that loaded and unloaded each hold rose alongside the hatches.

In time, the three-island ships gave way to freighters with one island, either in the middle of the ship or toward the stern. The island included the bridge and living quarters, with the engine room below. The one-island ship provided room for more and bigger hatches and so made it easier to load and unload cargo. During World War II (1939-1945), shipyards in the United States built more than 3,000 one-island ships—the famous Liberty and Victory ships. Both types of ships were about the same size, but the Victory ships, powered by steam turbines, were faster. The Liberty ships had reciprocating steam engines (see **Steam engine** (Piston steam engines)). Both ships were built according to standard plans so that they could be mass-produced. They transported millions of troops and millions of tons of

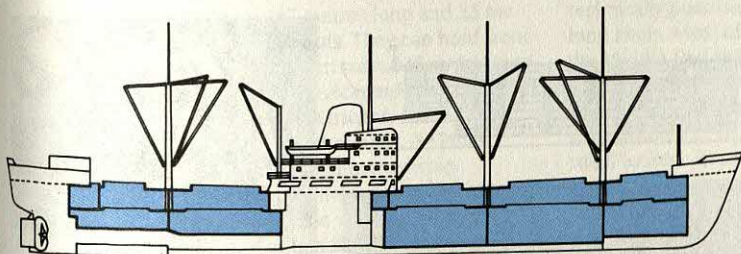
supplies to battlefields in every part of the world.

Traditional cargo ships. Since World War II, the traditional general cargo ship has steadily become more advanced. Today, it has powerful, electrically driven cranes and derricks. It can be loaded at the side and stern as well as at the hatches. It has automatic engine room controls and automatic navigation equipment. Yet the traditional general cargo ship has steadily been declining in use, chiefly because of high operating costs. A typical ship may carry cars, sacks of flour, cases of wine, television sets, aeroplane engines, crates of china, and a variety of other items. Loading and unloading such a mixture of items of varying shapes and sizes requires much time and labour and is, therefore, expensive. As a result, the number of ships designed to carry only one type of cargo—tankers and dry bulk carriers, for example—has increased. Specialized versions of the general cargo freighter have also been developed. They include container ships, roll-on/roll-off ships, and LASH ships.

Container ships eliminate the individual hatches, holds, and derricks of the traditional general cargo vessel. The hull of a container ship is simply an enormous warehouse divided into *cells* by vertical guide rails. The cells are designed to hold cargo in prepackaged units

General cargo ships

General cargo ships carry "package" goods—that is, anything that can be put into a package or that forms a package in itself. Loading such cargo onto a ship and fitting the individual pieces into the holds require much time and labour—and are therefore costly.



The coloured areas in the diagram, *above left*, indicate the cargo holds of a general cargo ship. The picture, *left*, shows a modern vessel. Most cargo is swung aboard on flat platforms called *pallets*, *above*, or in nets called *slings*. Derricks on the ship lift the cargo from the dock and lower it into the cargo holds.

called *containers*. Most containers consist of a standard-sized aluminium box that measures either 6 metres by 2.5 metres by 2.5 metres, or 12 metres by 2.5 metres by 2.5 metres. A 12-metre container is about the size of a railway wagon.

Manufacturers load their finished goods—anything from perfume to electronic products—into the containers, which are provided by the shipping company. They then have the containers delivered to the dock by road or rail for loading onto the container ship. The ship does not need a large gang of men spending hours to fit various items into different holds. Giant cranes pick up the containers, swing them over the ship, and then lower them one upon the other into the cells. After the hold has been loaded, additional containers are stacked on the deck.

Containerization saves shippers much money. A container ship can be loaded and unloaded in a small fraction of the time it takes for a conventional cargo vessel. Thus, labour costs are cut sharply. There is also less breakage and less danger of cargo shifting during a voyage. In addition, there is far less theft of valuable merchandise because the containers are sealed.

The largest container ships measure about 210 metres long. They can carry over a thousand 6-metre con-

tainers that hold a total of about 10,900 metric tons of cargo. Each of these ships equals the cargo-carrying capacity of 17 standard World War II freighters.

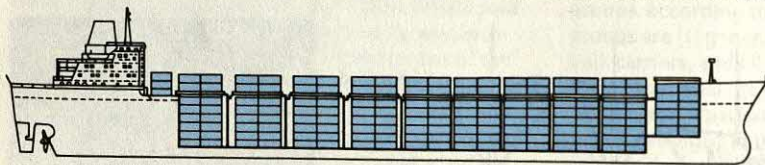
Many shipping companies believe that containerization is the greatest advancement in shipping since the invention of the steamship. Containerization of cargo began about the mid-1950's. Today, major shipping companies throughout the world operate or are building fleets of container ships.

Roll-on/roll-off ships take containers mounted on a framework of wheels like a truck trailer. These ships have a stern opening and side openings. Dockworkers drive the containers up ramps onto the ships and then, by way of inboard ramps or elevators, take them to their assigned places. Roll-on/roll-off ships also carry cars, buses, caravans, trucks, and any other cargo that can be rolled aboard. An international partnership, the Atlantic Container Line, put the world's largest roll-on/roll-off ships into operation in 1987. The five ships are 292 metres long and can do 18 knots. Each one can carry about 1,100 12-metre containers and about 1,000 cars and trucks.

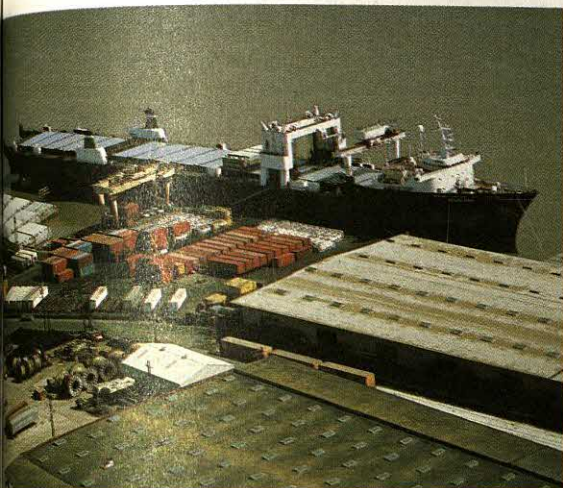
LASH ships are huge freighters that carry preloaded seagoing *lighters* (barges) stacked one upon the other. The term *LASH* stands for *Lighter Aboard Ship*. The

Container ships

Container ships carry goods of all kinds in metal containers, most of which measure 2.5 metres deep, 2.5 metres wide, and 6 or 12 metres long. A container ship can be loaded and unloaded in about a fifth of the time it takes to unload a conventional cargo ship.



The coloured areas in the diagram, above left, indicate the cargo space on a container ship. The picture above shows a giant crane stacking containers in a ship's cells. After all the cells are filled, additional containers are stacked on the deck. The fully loaded ship, left, then leaves the port facility.



LASH ships carry *lighters* (barges) preloaded with any kind of cargo. *LASH* means *Lighter Aboard Ship*. Cranes on the carrier ship lift the lighters aboard and unload them.

lighters are loaded at upriver ports with any kind of cargo and then towed by tugs to the seaport. There, cranes on the carrier ship lift the barges on board. The freighter then carries the barges to a seaport across the ocean. There, the barges are lowered into the harbour and then towed upstream to their final ports.

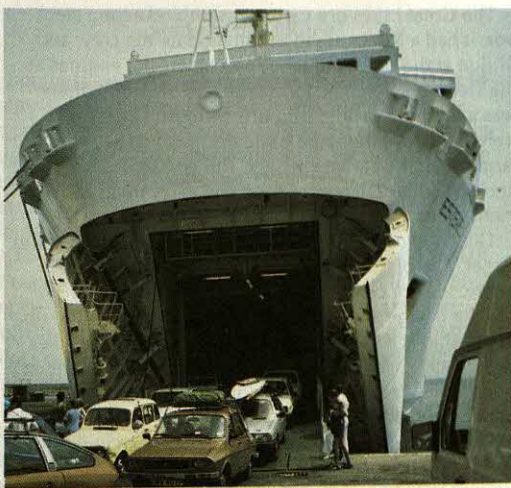
LASH ships measure up 267 metres long and 33 metres wide and can travel at 20 knots. They can hold from 70 to 90 barges, each of which can carry 336 metric tons of cargo. The first LASH ship, the *Acadia Forest*, began operation in 1969 between New Orleans, in the United States, and Rotterdam, in the Netherlands. A United States line operates the Norwegian-owned ship.

Modernization of ports. Container ships need special port facilities. Throughout the world, ports are being built or modernized to handle these vessels. The new facilities have giant cranes and other lifting equipment because container ships have few or no derricks. In port, the ships chiefly need large open areas where their thousands of containers can be left while awaiting loading or pickup. The most advanced ports use computers to assign the loading and pickup areas.

Tankers

Tankers were among the first ships designed to carry only one kind of cargo—petroleum. Earlier ships carried oil in barrels and then in large tanks. In 1878, Ludwig Nobel of Sweden launched a ship that was simply one great tank itself. Nobel was the brother of Alfred Nobel, founder of the famous Nobel Prizes. His tanker carried oil from the Baku fields in southeastern Russia across the Caspian Sea.

In 1885, the first oceangoing tanker, the *Glückauf*, was launched. This ship, built in Great Britain for a German oil company, carried petroleum from the United States to Europe. It became the model for all later tankers. Its hold space had eight big tanks, and its engine room was set in the stern to reduce the danger of fire. The vessel



Roll-on/roll-off ships carry cars, trucks, and any other cargo that can be rolled aboard through stern or side openings. Some of these ships are also equipped to handle containers.

was 90 metres long and 11 metres wide. It carried 2,090 metric tons of oil and could travel at 9 knots.

Today, large tankers, often called *supertankers*, can measure more than 457 metres long and 60 metres wide. They carry more than 450,000 metric tons of oil and can do about 15 knots. Even larger supertankers are technically possible. But these giants are useful only for long hauls. Most of them are used to transport oil from the Middle East to Europe and Japan.

Supertankers have various economic advantages over smaller tankers. For example, it costs much less to ship a large amount of oil in one supertanker than in many small tankers. But supertankers also have major disadvantages. Their huge size makes them difficult to navigate and increases the risk of accidents. Because of their size, supertankers require ports as deep as 30 metres in order to unload. If a supertanker suffers an oil spill, the pollution that results could be disastrous because of the ship's huge capacity.

Most tankers carry petroleum. But some tankers are designed to haul other kinds of liquid cargo, such as liquid natural gas (see **Tanker** [Liquefied natural gas carriers]). Ships called *ore-bulk-oil carriers* (O/B/O's) can serve as either tankers or dry bulk carriers. These ships are discussed in the following section of this article.

Dry bulk carriers

Dry bulk carriers transport fertilizer, grain, ore, powdered detergents, salt, sugar, wood chips, or any other cargo that can be piled loose into a hold. The first modern bulk carriers included the specially designed boats that began hauling iron ore on the Great Lakes of North America during the late 1800's. Like tankers, these vessels were designed to carry only one kind of cargo. But unlike tankers, the ore carriers hauled solid cargo. As a result, they required more complicated loading and unloading arrangements than tankers, which needed little more than hose connections and pumps.

The Great Lakes ore carrier resembled a long steel box. It had a forecastle to accommodate the crew and bridge at the bow, and a poop to house the engines at the stern. Between the forecastle and the poop, there was a long bin to hold iron ore. Modern Great Lakes freighters have the same basic design, but they are larger than the earlier carriers. The largest vessels today are more than 210 metres long and carry up to 22,700 metric tons.

Oceangoing bulk carriers have also grown larger and larger. The biggest ones can carry more than 91,000 metric tons of cargo. A modern seagoing bulk carrier has the bridge and engine room near the stern. The rest of the ship is a level area of deck with a line of hatches giving access to the holds. Motor-driven equipment on board quickly removes the enormous hatch covers for loading and unloading.

During the late 1950's, shipbuilders began to design vessels that could haul either ore or oil. These ships are called *O/O* carriers. During the 1960's, another new type of carrier appeared—the *O/B/O*. An *O/B/O* ship can haul ore; light bulk cargo, such as grain or fertilizer; or oil. The largest *O/O* ship can haul about 227,000 metric tons of cargo. The largest *O/B/O* vessels can carry up to 136,000 metric tons.

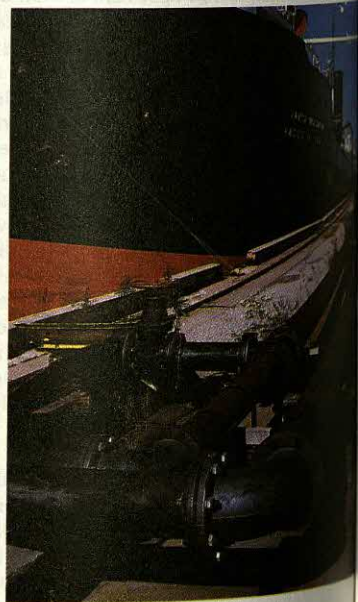
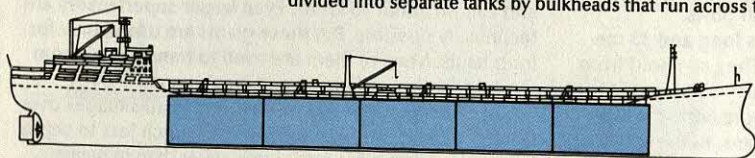
Barges are somewhat like small bulk carriers. These boxlike vessels haul such cargoes as cement, coal, grain, gravel, and sand across harbours, on canals and rivers, and along coasts. Before the invention of power-driven machinery, sails propelled most canal and river barges. In areas where the wind was unreliable, men or animals trudged along the bank of a canal or river and pulled the barges. In Egypt, India, and some other countries, barges are still towed in this way. Modern barges have diesel motors or are towed by tugs. The size of a canal or river barge is limited by the waterway on which it operates. The barge must be short and narrow enough to get round the bends, and through the locks in the waterway. Barges that operate in coastal waters can be practically any size.

Multipurpose ships

Multipurpose ships are designed to haul several kinds of cargo at the same time. An example is the British ship *Strathardle*, launched in 1967. It has refrigerated space for foods that spoil easily, tank space for liquid cargo, and a deck for cars. The vessel is 172 metres long and 24 metres wide. Another multipurpose ship is the *Bore VI*, a small Finnish freighter also built in 1967. It carries roll-on/roll-off vehicles, large rolls of paper,

Tankers

Most tankers transport petroleum, but some are specially designed to haul other kinds of liquid cargo, such as liquid natural gas. The interior of an oil tanker resembles a huge ice cube tray. It is divided into separate tanks by bulkheads that run across the width and length of the ship.



The coloured areas in the diagram, above left, indicate the separate tanks that make up an oil tanker's cargo space. Petroleum is pumped into a tanker at oil terminals through large hoses. The picture, left, shows an oceangoing modern tanker after loading. The ship's own pumps unload the oil, above.

packaged timber, and general cargo. This ship is 88 metres long and 15 metres wide. A similar multipurpose vessel is the American ship *Mormacsea*, which was launched in 1968. It can carry containers, roll-on/roll-off cargo, and general cargo. It also has refrigerated space. The *Mormacsea* measures 183 metres long and 27 metres wide.

Specialized types of vessels

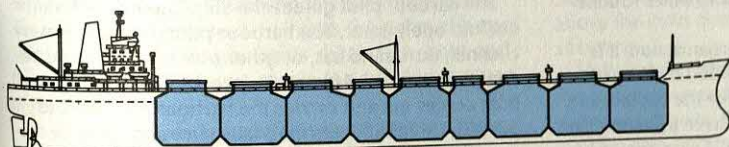
Many ships and boats have been designed to do particular jobs. Refrigerator ships, travelling at 22 knots or faster, speed fresh fruits, meat, and vegetables across the ocean. Tugboats tow barges along canals and rivers and guide huge passenger liners and freighters in and out of harbours. Ocean-going tugs take part in rescue and salvage work. Besides ferries that transport vehicles and passengers, there are train ferries that carry railway wagons across small bodies of water. Powerful ice-breakers use their sturdy bows to ram through frozen waters and open a path for other ships and boats. Oceanographic ships carry instruments to study currents, tides, waves, and the animals and plants of the sea. Some modern fishing vessels are used not only to catch fish, but also to process them. These ships have equipment to behead, clean, and refrigerate the fish.

Bulk carriers

Dry bulk carriers carry grain, ore, and other cargo that can be loaded *in bulk* (loose). Bulk carriers called *O/O* ships carry oil or ore. *O/B/O* ships carry oil or ore or other dry bulk cargo. These *combination* ships do not haul oil and dry cargo at the same time.

Ships of the future

Future ships will be even more efficient than those of today and so will cost less to operate. More and more ships will carry containerized cargo, and all ships will be larger. Revolutionary new designs for some types of vessels have been proposed. These include flexible barges for transporting bulk fluids, such as oil and liquid gas; and submarines that do not need water ballast tanks. Ships will become increasingly automated. A staff of engineers will no longer need to stand watch in the engine room. Instead, ship engines will be operated from the bridge, just as plane engines are run from the pilot's cabin. Electronic equipment will navigate tomorrow's ships automatically. A computer will determine a ship's course and, by sending the information to machinery that regulates the rudder, steer the vessel. As a result of these developments, ship officers will receive increased technical training. Crews will become smaller. Ship maintenance will no longer be done at sea by the crew, but in port by specialized workers. To avoid such maintenance work as painting, the bridge, cabins, and other structures on the main deck will be built of aluminium and other materials that do not rust and that resist wear from the chemicals in seawater.



The coloured areas in the diagram, above left, indicate the holds of an *O/B/O* ship. The picture, left, shows a bulk carrier that hauls grain. Most dry cargo is loaded and unloaded by power scoops or by such shore-based suction devices as this one, above, shown loading grain. Some bulk carriers have built-in conveyors.

The officers and crew of a ship work as a team to see that the passengers, the cargo, and the ship itself arrive at their destination safely and on time. To sail a ship long distances across open water requires great skill and experience. A change in the wind's strength or direction, or the force of the waves and currents, can put a ship off course. A ship's officers use equipment and methods developed hundreds of years ago—as well as modern devices—to enable them to fix the location of their ship at all times.

Officers and crew. A highly organized team of officers commands a ship. The chief officer, called the *captain* or *master*, has final authority over and final responsibility for the passengers, crew, cargo, and ship. The captain has a number of deck officers, called *mates*, as assistants. The captain has at least a chief, or first, mate; a second mate; and a third mate. On large passenger ships, the captain may have one or two additional mates. All these officers are highly trained in all aspects of running the ship. They must have a licence, which they receive after passing a test given by a nation's government or some other authority. The officers navigate the ship and command the deck crew.

The deck crew consists of *able-bodied seamen* (A.B.'s) and *ordinary seamen*. Many countries issue certificates of competence for both groups of crewmen. Able-bodied seamen have more experience than ordinary seamen and have the more responsible tasks, such as keeping watch, helping to steer, and making difficult repairs. Ordinary seamen do cleaning and other routine maintenance work.

The engine room has a separate organization. It is headed by a *chief engineer*, who is aided by first, second, and third *assistant engineers*. Like the captain and deck officers, all the engineers must have a licence. The crew members in the engine room of a ship driven by steam turbines include oilers, who help tend the engines, and firemen, who fire the boilers.

A ship also has a number of other crew members. They include a chief radio operator; a chief steward, who is in charge of obtaining, preparing, and serving food; one or two cooks; and a mess staff, who serve the meals and assist the cooks.

Cargo and passenger ships carry the same basic groups of crew members. But large passenger liners and cruise ships have much larger crews to make a voyage as pleasant as possible for the passengers. The extra crew members include bakers, hairdressers and beauticians, bar staff, butchers, doctors and nurses, entertainers, launderers, printers, *pursers* (accountants), recreation directors, and a large staff of stewards and stewardesses. A big passenger or cruise ship is like a floating hotel, and may carry as many as one crew member for every two passengers.

Navigating a ship. When a large ship leaves port, three or four small tugboats pull it from the quayside into the harbour. A *docking pilot* directs the tugs and the ship until the vessel clears the quay and is underway in the harbour. The tugs then leave the ship and the docking pilot turns the vessel over to a *harbour pilot*. Every merchant ship enters and leaves port with a local harbour pilot aboard.



The bridge of a modern ship has highly accurate navigation equipment for steering the vessel and keeping it safely on course under all conditions. Such equipment includes radar, an automatic pilot, and an electronic navigation system.

The harbour pilot guides the ship into the harbour or out into open water. The harbour pilot must know every channel, turn, sand bar, or other obstacle that could endanger the vessel. After a ship reaches open sea, a small boat comes out and carries the harbour pilot back to port. The ship's officers then take over and navigate the vessel to its destination.

On the bridge, the navigator, usually the second mate, uses various equipment to locate the ship's position. As sailors have done for thousands of years, the navigator checks the position by observing the sun, moon, planets, and stars. For hundreds of years, the most important navigation devices have included a *compass* to tell direction, a *chronometer* to tell the exact time and help determine a ship's longitude, and a *sextant* to calculate a ship's latitude by measuring the angle of the sun or of a star above the horizon. See **Compass; Chronometer; Sextant**.

Modern ships also have highly accurate electronic navigation equipment. Many ships have devices for determining their position through radio signals. These signals are sent out continuously by special transmitting stations along the coasts of busy trade routes. One such system is called *loran*, for *long range navigation*. With loran, an accurate position can be obtained in bad weather and poor visibility without a compass, chronometer, or sextant (see **Loran**). Many ships also can determine their position by signals that are transmitted from orbiting space satellites.

Modern ships also carry radar. At night and in bad weather, a ship's radar can spot icebergs, rocks, and other vessels in time to prevent a collision (see **Radar**). Some modern ships also have an automatic pilot, which,

after a ship has been set on course, holds it there. This device is linked to a *gyrocompass*, which determines direction, and it operates the rudder automatically (see *Gyrocompass*). In spite of all these remarkable devices, navigators still also use the tried-and-true compass, chronometer, and sextant. For more information on how ships are navigated, see *Navigation*.

Automation aboard ships is increasing, but no ship is as yet completely automated. Most automation has been in the engine room. When the officer on the bridge signals the engines to go ahead or backward or to change speed, the engineer no longer has to make adjustments by hand. Instead, the engines respond immediately. The operation of the valves and the necessary change in temperature or pressure are taken care of automatically. Many ships have automatic navigation aids and automatic devices to speed up the loading and unloading of cargo. Automation may one day make it possible for cargo ships to have only 9 or 10 crew members.

Safety at sea. Safety standards for ships have been set up by International Safety of Life at Sea conventions, which were held in 1914, 1929, 1948, 1960, and 1972. All the major maritime nations have agreed to these standards. The standards require that ships have watertight *bulkheads* (compartment walls); fire-fighting equipment; and enough lifeboats, life jackets, and other lifesaving equipment. Other rules provide that lifesaving and fire drills be carried out at regular intervals. In addition, ships must follow the International Rules of the Road. These rules deal with such points as the rights of way of ships on the high seas, the lights ships must show, and the signals that ships must give in fog and during times of distress.

In 1930, all the leading seafaring countries accepted rules set up by the International Load Convention to keep ships from being overloaded. These rules require that cargo ships have a series of short lines painted on their side to show the depth to which the vessels may be safely loaded at various times of the year and in various waters. When a ship, being loaded with cargo, sinks in the water to a certain line, it has reached the maximum load. The lines are called *Plimsoll marks*. They are named after Samuel Plimsoll, a member of the British Parliament who brought about their adoption in Great Britain's Merchant Shipping Act of 1876. In 1966, the world's maritime nations agreed to new rules that raised the limits to which ships may be safely loaded. The new rules reflected improvements in ship design and construction since 1930. See *Plimsoll mark*.

In addition to international maritime laws, individual countries have regulations governing the construction and operation of their own ships.

In some cases, these safety standards are far higher than international rules require. New ships are inspected during construction to make sure that they are being built according to regulations, and to the plans approved by the shipping authority. Ships built to the highest standards are exceptionally safe, but may also be more costly to build and operate than ships built in countries with lower standards. Ships in service are also checked to make sure that they meet safety regulations.

Passenger ships, such as ferries, are checked to make sure that they do not carry too many passengers, and have enough lifesaving equipment such as lifeboats.

Shipbuilding

A ship is one of the most complicated objects ever made. It is actually a floating city that generates its own power, heat, and electricity. A ship carries its own fuel and provisions. It can make its own fresh water from the sea, and it disposes of its own rubbish.

All ships have four main parts. In designing a ship, naval architects plan these and other parts of the vessel so that it meets a shipping company's special needs as well as government safety regulations. A shipyard then builds the ship according to the architect's plans.

The chief parts of a ship are (1) the hull, (2) the engines, (3) the propellers, and (4) the rudder.

The hull is the watertight shell of a ship. It is divided into a number of horizontal surfaces called *decks*. *Bulkheads* are walls built between the decks, forming compartments. Each compartment has special doors that, when closed, make it watertight. If water floods one compartment because of an accident, closing the doors will trap the water there and prevent it from flooding other compartments. Watertight compartments enable a ship to float even if a section of its hull is pierced.

The deck at the top of the hull is called the *main deck*. Several more decks may be above it. All the structures above the main deck make up what is called the *superstructure*.

Hulls have a pointed bow so they can knife swiftly through the water. Most hulls also have a rounded stern, which helps the water close smoothly behind as the ship cuts through the water. The overall shape of a hull is designed to make the ship as *stable* (steady) as possible. A ship must not *roll* (rock from side to side) or *pitch* (rock from front to back) too much. Most modern ships also use stabilizing systems to reduce rolling. One such system has a horizontal underwater fin on each side of the hull. The fin moves upward on the descending side of the ship and downward on the ascending side and so reduces the roll.

To increase stability further, ships carry extra weight called *ballast*. Without ballast, an empty cargo ship would bobble about in the ocean like a cork. Most ships use seawater as ballast. As a ship takes on cargo, the ballast water is pumped out.

The engines of most ships are steam turbines, gas turbines, or diesel engines. The largest and fastest ships have steam turbines. Steam produced in the boilers spins the bladed wheels of the turbine. The turbine, through a series of *gears* (toothed wheels), drives the propeller shaft and makes the propeller revolve. On turboelectric ships, the turbine turns a generator that produces electricity for a motor. The motor, in turn, drives the propeller.

Almost all merchant ships use oil as the fuel to heat the boilers that create the steam. On nuclear-powered ships, a nuclear reactor creates the steam. Many of the most advanced ships have gas turbines. Gas turbines

work much like steam turbines but use hot gases instead of steam. See **Turbine**.

Vessels propelled by diesel engines are called *motor-ships*. They have either *geared-drive* or *diesel-electric* machinery. On a geared-drive ship, the engine works through gears to turn the propeller. On a diesel-electric ship, the engine turns a generator that supplies current to an electric motor connected to the propeller shaft. See **Diesel engine**.

The propellers move a ship through the water. The engine turns a shaft that juts out underwater from the stern. The propeller is bolted to the end of the shaft. Most propellers have four blades. As a propeller turns, it screws itself through the water and so pushes the ship forward. Most small ships have one propeller. Many larger vessels have two propellers, and very big ships have four. Additional screws increase a ship's power and make the vessel easier to manoeuvre. For example, a twin-screw ship can be swung around quickly by going forward on one propeller and backward on the other. See **Propeller** (Marine propellers).

The rudder is a large flat piece of metal that steers a ship. It is hinged to the stern and so can be swung like a door. The rudder is connected to the *helm* (steering wheel) on the ship's bridge. When the crewman at the helm turns the wheel to the right, the rudder moves to the right, causing the stern to swing left and the bow to swing right. When the helm is turned to the left, the rudder and bow swing to the left.

Other parts and equipment of a ship include *funnels* to discharge smoke and exhaust fumes, an *anchor* on the left and right sides of the bow, and enough lifeboats to hold all people on board. Modern ships have power-driven *winches* to raise or lower the anchors and to bring in or let out the *mooring lines* used to tie vessels at the quayside. Power-driven winches also operate the cranes for loading and unloading cargo. Modern ships also have high-speed pumps to pump out ballast water or to pump up seawater in case of fire. Radio-telegraph equipment keeps ships in constant touch with the rest of the world.

Designing and constructing a ship. Before naval architects begin to design a ship for a shipping company, they must know how the company plans to use the vessel. They must know where the ship will travel, what kind of cargo it will carry, and how fast it will have to travel. Architects also must be aware of government safety regulations. In addition, they must adjust their designs to allow for the ever-increasing use of automation on ships.

The shipyard carefully follows the architect's designs in building a ship. Traditionally, construction begins with the laying of the keel. Workers then build the ribs that support the hull and give it shape. Next, they weld the metal plates that form the middle section of the hull. As the middle section is built, the various compartments, the boilers, and the necessary machinery are added. Finally, the bow and stern are built.

Modern shipyards no longer construct ships in this piece-by-piece manner. Instead, they first build enormous prefabricated sections of the ship. Many of these sections have some wiring and piping built into them. Giant cranes then carry these huge sections to a framework called a *shipway*, where they are welded together. There is no laying of the keel. As the double-bottom sections of the hull are welded together, the keel is laid automatically. The entire hull may consist of as few as 20 prefabricated units. After the hull is completed, parts of the superstructure are added. The ship is then ready to be launched.

Launching and outfitting a ship. Shipbuilders launch a ship after it is about 70 to 90 per cent completed. The ship is slid down a runway of heavily greased timbers into the water. Most ships are launched stern first. A ship launched bow first would plough down into the mud. Ships built along rivers too narrow for stern launching are launched sideways. Some yards build their ships in dry docks below the water level. After the hull and superstructure have been completed, workers open the valves and flood the dock. The ship then gently floats off the blocks that support the bottom of the hull. After the water inside the dock reaches the level of the water outside it, the dock gate is opened and the ship is launched.

Just before a ship is launched, it is named. The shipping company selects a person, usually a woman, as the ship's sponsor. This person names the vessel and breaks a bottle of champagne across its bow. At that instant, the ship begins to slide into the water.

After a ship has been launched, a tug pulls it to an *outfitting dock*. There, workers complete the superstructure and add the interior furnishings. The ship then makes its *builder's trials* with observers aboard from the company that ordered the ship. They make sure that all the equipment is in good working order and that the ship performs manoeuvring, speed, and other tests according to the specifications. If the ship returns from the trials with a broom tied to the mainmast, it has made a "clean sweep" of its tests and the shipping company has accepted delivery of the vessel.

Merchant fleets of the world

Altogether, the countries of the world have about 75,000 merchant ships. The vessels total about 400 million gross tons. Each year, about 17 million gross tons of new shipping are built. Japan and South Korea produce about two-thirds of the total gross tonnage of ships that is launched annually.

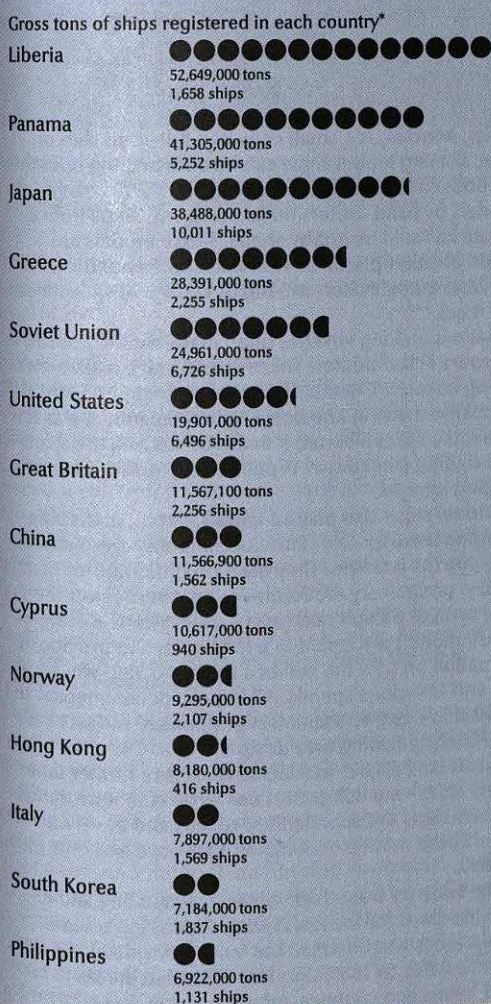
Many countries have a long tradition as seafaring nations. They include Denmark, France, Great Britain, Italy,

the Netherlands, Norway, and Sweden. Some of these countries now have much smaller merchant fleets than formerly, and build fewer ships themselves than they used to. Japan and a number of other nations have been enlarging their fleets.

The size of the world's merchant fleet varies according to the level of world trade. Important trading nations, such as the United States, Britain, or Germany, do

not necessarily carry all their trade in their own ships. For example, the United States is the chief trading country of the world, but only about 4 per cent of its foreign trade is carried in ships flying the American flag. The United States merchant fleet consists of about 6,500 ships, including those that sail on the Great Lakes and other inland waterways. These ships are registered in the United States and fly the American flag. Only about 120 American-flag ships are engaged in its foreign trade. This is because American ship operators buy ships from shipyards in other countries, which build ships more cheaply. These ships are registered under the flag of another nation, such as Panama and Liberia. Other countries do the same. Shipping companies register their ships under a foreign flag, and hire lower-paid foreign crews. They may also avoid strict safety regulations, and pay lower taxes. A number of nations allow their flag to

Leading merchant fleets of the world



*Includes ships of 100 gross tons or more; 1 gross ton is equivalent to 2.83 cubic metres of space.
Source: Lloyd's Register of Shipping, Statistical Tables, 1986.

Flags and funnels of shipping countries

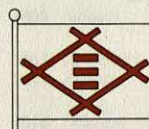
Shipping companies fly a private flag, called a *house flag*, to identify the ships they own or operate. On many merchant ships, the colours and emblem of the flag also appear on the funnel.



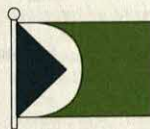
American President Lines
(United States)



Italian Line
(Italy)



Mitsui O.S.K. Lines, Ltd.
(Japan)



Canadian Pacific (CP Ships)
(Canada)



Cunard Line Ltd.
(Great Britain)



French Line (Compagnie)
Générale Transatlantique
(France)



be used in this way as a *flag of convenience* for a registration fee.

Some governments grant *subsidies* (grants of money) to support their shipbuilding industries. This enables them to build ships more cheaply than elsewhere. Maritime nations, which depend on seaborne trade, may subsidize their merchant fleets. Governments do this because they believe that a merchant fleet is vital to the country's foreign trade and defence. For example, without a merchant navy, the nation would be completely dependent on foreign shipping lines. During wartime, a nation may well depend on its cargo ships to carry supplies, and on shipyards to repair and build warships. In an emergency, a government may requisition merchant ships for military use. This was done by the British government in 1982 during the Falklands conflict with Argentina.

Liberia has the world's largest merchant fleet. This country has about 53 million gross tons of ships registered under its flag, which it allows to be used as a flag of convenience. Liberians themselves own only a few ships. Companies of other countries own almost all Liberian-flag vessels. These companies register their ships in Liberia rather than in their own countries because Liberia has lower taxes, allows shipowners to pay lower wages, and does not require many costly safety features. Other countries that have a flag of convenience include the Bahamas, Honduras, and Panama.

By the end of World War II, Japan's merchant fleet had fallen to about 1 1/4 million gross tons. Today, the

country has about 40 million gross tons of ships. Only Liberia and Panama have larger fleets. Japan has also become the world's leading shipbuilding nation. However, South Korea has greatly increased its shipbuilding and

now produces almost as much shipping as Japan. About 75 per cent of the shipping built by the Japanese is sold to foreign lines. South Koreans sell about 85 per cent of the shipping they produce to foreign lines.

Study aids

Related articles in *World Book* include:

Biographies

Cunard, Sir Samuel	Kaiser, Henry J.
Ericsson, John	Onassis, Aristotle S.
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Fulton, Robert	

Famous ships

Clermont	Savannah
Lusitania	Titanic
Mayflower	

Kinds of ships

Barge	Galley
Brig	Hovercraft
Caravel	Hydrofoil
Clipper ship	Icebreaker
Ferry	Junk
Flatboat	Steamboat
Frigate	Tanker
Galleon	Tugboat

Parts of a ship

Automatic pilot	Gyrostabilizer
Anchor	Propeller
Gyrocompass	

Other related articles

Barnacle	Merchant navy
Boating	Navigation
Dock	Navy
Dry dock	Port
Flag	Radar (In ship navigation)
Harbour	Sailing
Inland waterway	Salvage
Insurance (Other kinds of property and liability insurance)	Ship, Model
Knot	Ship money
Log	Shipwreck
Maritime law	Transportation

Outline

- I. History
- II. Ships of today
 - A. Passenger vessels
 - B. Classification of cargo ships
 - C. General cargo ships
 - D. Tankers
 - E. Dry bulk carriers
 - F. Multipurpose ships
 - G. Specialized types of vessels
 - H. Ships of the future
- III. A ship at sea
 - A. Officers and crew
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 - D. Safety at sea
- IV. Shipbuilding
 - A. The chief parts of a ship
 - B. Designing and constructing a ship
 - C. Launching and outfitting a ship
- V. Merchant fleets of the world

Questions

- What is a *flag of convenience*? Why do many shipbuilders register their ships under these flags?
- What was the first commercially successful steamboat? Who built it?
- Why has the transatlantic passenger liner service declined sharply since the late 1940's?
- What does it mean if a new ship comes back from its builder's trials with a broom tied to the mainmast?
- Who was Donald McKay? Isambard Kingdom Brunel? John Fitch?
- What is the difference between a tramp ship and a cargo liner?
- Why did the invention and development of the steam engine revolutionize water transportation?
- What are some of the standards of safety that ships are required to follow?
- How does a container ship differ from a traditional general cargo ship?
- What does a docking pilot do? A harbour pilot?

Ship, Model, is a small copy of a full-sized ship or boat. Making model ships can be a fascinating hobby for both children and adults. Some hobbyists carve models by hand. Others make boats and ships from accurate kits sold by hobby shops. These models are made of either plastic or wood. In some countries, sailing boat modelmakers belong to clubs that sponsor sailing races.

Sailors on long voyages often made model ships in narrow-necked bottles. These model ships make interesting collectors' items. The spars and rigging of the ship were made in fine detail. When the model was finished, the sailor inserted it in the bottle with the spars and rigging lying down. A pull of one thread drew the rigging upright.

Model ships also play an important part in the shipbuilding industry. Old-time shipbuilders carved models to guide the workers. They used no blueprints or plans. Today, preliminary models help designers select the final form of a ship's hull before they draw the design. These models are tested in a towing tank to provide information on how the hull of a full-sized ship will act at sea and at various speeds. All important commercial and naval ship designers tank-test preliminary models before finally deciding on a design.

Museums display models of vessels of former times. Many steamship companies use large elaborate models of their ships to decorate their offices and travel bureaux. These models sometimes cost large amounts of money.

Ship money was a form of tax levied in England to provide ships for the Royal Navy. Since Anglo-Saxon times, kings had imposed the tax on seaside towns and counties. But, in 1635, Charles I extended the tax to inland towns and counties. John Hampden, a wealthy squire, refused to pay because he thought the King had no right to impose taxes on the whole country without



Model ships provide accurate re-creations of vessels of the past. This craftsman in Greenland is producing carefully researched models of Viking long ships to sell as souvenirs.

the consent of Parliament. In 1637, a majority of judges decided in favour of the king. Ship money was made illegal in 1641.

Shipping. See **Ship**.

Ship's bell. See **Ship** (table: Nautical terms).

Shipworm is a kind of marine mollusc that bores in wood. They bore downward and inward with two small clamlike shells. They line the tunnel with a white shelly material. Shipworms are *bivalves* (animals with a two-pieced shell). Young shipworms look like tiny clams and can swim about freely. But they soon attach themselves to wood and begin to bore a hole in it. Shipworms have been known to bore up to 2 centimetres in a day and to honeycomb timber within six months.

Scientific classification. Shipworms are in the shipworm family, *Teredinidae*. They make up the genera *Bankia* and *Teredo*. The common shipworm of Europe, Africa, and North America is *Teredo navalis*.

Shipwreck is the destruction or loss of a ship. Shipwrecks have various causes. A ship may be destroyed by fire or it may sink after colliding with another vessel.

Safety devices used to help prevent shipwrecks include *electronic depth finders* to help keep ships from going aground and *radar* to make navigation safer at night (see **Fathometer**; **Radar** [In ship navigation]). International agreements, including the International Conventions for the Safety of Life at Sea (SOLAS), set up safety standards for ships. The International Ice Patrol protects ships by furnishing information on drifting ice and icebergs.

See also **Batavia**; **Dunbar**; **Salvage**; **Ship** (Safety at sea); **Titanic**.

Major shipwrecks

Year	Ship	Dead	Disaster
1833	<i>Lady of the Lake</i>	215	struck iceberg in N. Atlantic
1835	<i>George III</i>	134	wrecked off Tasmania
	<i>Neva</i>	225	sank in Bass Strait, Australia
1852	<i>Birkenhead</i>	420	wrecked off South Africa
1853	<i>Annie Jane</i>	348	wrecked off Scotland
1854	<i>City of Glasgow</i>	399	vanished out of Liverpool, England
1857	<i>Central America</i>	422	sank on Cuba-New York run
	<i>Dunbar</i>	121	wrecked off Sydney, Australia
1858	<i>Austria</i>	509	burned in North Atlantic
1859	<i>Pomona</i>	388	wrecked off Ireland
1863	<i>Orpheus</i>	189	sank off Auckland, New Zealand
1865	<i>Sultana</i>	1,653	exploded on Mississippi R., U.S.A.
1867	58 vessels	1,000	hurricane in West Indies
1873	<i>Atlantic</i>	500	wrecked off Nova Scotia, Canada
1878	<i>Princess Alice</i>	640	collided in R. Thames, England
1891	<i>Utopia</i>	533	collided off Gibraltar
1895	<i>Reina Regenta</i>	402	foundered near Gibraltar
1898	<i>La Bourgogne</i> and <i>Cromartyshire</i>	561	collided off Nova Scotia, Canada
1904	<i>General Slocum</i>	1,030	burned in East River, U.S.A.
	<i>Norge</i>	651	wrecked off Scotland
1912	<i>Titanic</i>	1,500	struck iceberg in N. Atlantic
1914	<i>Empress of Ireland</i>	1,029	collided in St. Lawrence R., Canada
1915	<i>Eastland</i>	812	overturned in Chicago R., U.S.A.
1917	<i>Mont Blanc</i>	1,635	exploded in Halifax Harbour, Nova Scotia, Canada
1931	<i>St. Philibert</i>	368	overturned off France
1934	<i>Morro Castle</i>	134	burned off New Jersey, U.S.A.
1942	<i>Curacao</i>	335	collided off England
1943	<i>Centaur</i>	268	torpedoed off Queensland, Australia
1948	<i>Kiangya</i>	1,100	exploded in China Sea
	<i>Taiping</i>	600	collided off China
1952	<i>Hobson</i>	176	collided in Atlantic
1953	<i>Chang Tyong-Ho</i>	249	sank off Pusan, South Korea
	<i>Princess Victoria</i>	134	sank off Northern Ireland
1954	<i>Toya Maru</i>	1,172	sank in Tsugaru St., Japan
1958	<i>Uskudar</i>	361	capsized off Izmit, Turkey
1961	<i>Dara</i>	212	burned in Persian Gulf
	<i>Save</i>	259	sank off Mozambique
1963	<i>U.S.S. Thresher</i>	129	sank in North Atlantic
1964	<i>HMAS Voyager</i>	82	collided off Australia
1966	<i>Heraklion</i>	264	sank in Aegean Sea
1970	<i>Christena</i>	125	sank off St. Christopher
	<i>Namyong-Ho</i>	308	sank off South Korea
1981	<i>Tampomas II</i>	580	burned and sank in Java Sea
1983	<i>Tenth of Ramadan</i>	357	burned in Lake Nasser, Egypt
1986	<i>Admiral Nakhimov</i>	398	collided in Black Sea
1987	<i>Herald of Free Enterprise</i>	193	capsized off Belgium
	<i>Maria</i>	390	sank in Luapula River, Zambia
	<i>Dona Paz</i>	1,840	collided in Mindoro Strait, Philippines
1988	Patna ferry boat	400	sank in Ganges River, India
	<i>MV Hasail</i>	200	collided near Munshiganj, Bangladesh
1990	<i>Sein-Pan-Pya</i>	210	sank in Gyaing River, Burma
1991	<i>Salem Express</i>	475	sank in Red Sea, Egypt
1992	<i>Vierge Miracle</i>	400	sank in southern Bahamas
1993	<i>Neptune</i>	800	sank off Haiti

Sources: Lloyd's Register of Shipping; official government sources.

Shire was an administrative division of the Anglo-Saxon states of early England. Shires had definite boundaries and were made up of smaller districts called *hundreds*. The chief official of a shire was called a *reeve* or *shire-reeve*. The term *sheriff* derives from this title. Many counties in England have retained the word *shire* in their names, and many county boundaries follow those of the old shires. The word *shires* is sometimes used to refer collectively to the present-day counties. *Shire* is also the name of a heavy draught horse, first bred in the Midland shires of England.

See also **County**; **Horse**.

Shiva is one of the two leading gods of Hinduism. Vishnu is the other. Shiva, a god of great power, is beyond distinctions of good and evil. Hindus call him *the Destroyer* because he periodically destroys the world in order to re-create it again.

Shiva has a terrifying appearance. Many Hindus believe he haunts graveyards and lives with demons and other supernatural beings. But Shiva's followers consider him a merciful god, despite his fearsome characteristics. In Hindu philosophy, Shiva avoids taking an active part in human affairs. Hindu works of art show him meditating alone on a mountain. Many Hindus worship Shiva as the physical form of Brahman, the most abstract and absolute form of God. Shiva's wife, who has several names, plays an important part in human affairs.

See also **Brahman**; **Hinduism** (Divinities); **Sculpture** (Oriental India; picture).

Shivaji (1630-1680), a Hindu prince, founded the Maratha kingdom, in western India. He is regarded as a local hero because he represents the independent spirit of his region.

Shivaji was born in Fort Shivneri, Pune. His father, Shahji, was a general in the army of Bijapur, a kingdom in the Deccan ruled by a Muslim sultan. But his mother, who brought him up, encouraged Shivaji to expand his Pune estates and form an independent, Maratha homeland. From 1644, his kingdom grew as he challenged Bijapur and the Mughal emperor. In 1659, the sultan of Bijapur sent an army under Afzal Khan against him. Shivaji personally killed Afzal Khan and then defeated his army.

In 1664, Shivaji successfully raided Surat, the richest port of the Mughals on the west coast. In 1665, the Mughal emperor Aurangzeb sent a large force against him and forced him to agree to a treaty. The following year, Shivaji went to Agra to visit Aurangzeb, who trapped him there. Shivaji managed a daring escape and returned to his capital Raigad. In 1674, Shivaji was crowned as *raja* (ruler) and took the title *chhatrapati*.

Shock is a dangerous condition that can occur if the blood fails to circulate properly in the body. This condition is sometimes called *circulatory shock*. Shock can occur with any serious illness or injury. It can also be caused by emotional stress. Advanced stages of shock affect the body's vital functions and can be fatal.

A mild form of shock, called *neurogenic shock*, occurs when a person faints (see **Fainting**). More severe forms of shock progressively worsen if care is not provided. Many cases of the more severe forms of shock result from a sudden drop in the volume of blood circulating through the body, resulting in a drop in blood pressure. This can be caused by internal or external bleeding or by loss of fluid from burns or heat stroke. It

can also result from various heart disorders or from blood clots that block circulation. In addition, violent allergic reactions and certain bacterial infections cause blood vessels to expand and so lead to shock.

When a person first goes into shock, he or she perspires heavily and may feel restless, nauseated, or anxious. In most cases, the heart beats faster and breathing becomes rapid and uneven. As shock worsens, the brain does not receive enough blood, causing a change in the level of consciousness. If unaided, a person in this condition loses consciousness and dies.

In most cases, a person in shock should be positioned onto the back with the legs raised slightly. An individual in shock caused by heart trouble or difficult breathing should have the head and shoulders elevated. The person giving aid should maintain the patient's normal body temperature by keeping the patient warm with blankets if it is cool, or by cooling the patient if it is hot. Professional medical personnel may provide the patient with fluids and take measures to restore normal blood pressure. A doctor may administer drugs that regulate the size of the blood vessels, stimulate the heart, and fight infections or allergic reactions.

See also **First aid** (Treat for shock).

Shock, Electric. See **First aid** (Restoring breathing); **Shock treatment**.

Shock absorber is a device that reduces shock or concussion. It is used on car suspensions, aeroplane landing gears, and doors. Car shock absorbers also reduce unwanted vehicle motion caused by uneven road surfaces or by turning and braking manoeuvres.

Most shock absorbers consist of a piston inside a cylinder containing air or oil. In a car, the force of a bump is transmitted to the shock absorber, pushing the piston upward. But oil in the cylinder resists the piston. This absorbs the shock and offsets the force of the bump.

See also **Car** (The support system; diagram); **Spring** (metal); **Torsion bar suspension**.

Shock treatment is a type of therapy for patients with serious mental illnesses. Shock treatment makes the patient temporarily unconscious. Doctors use it alone or along with psychotherapy (see **Psychotherapy**).

The first widely used forms of shock treatment were *insulin shock therapy* and *electroconvulsive therapy* (ECT). Both forms were used for treating severe mental illnesses during the 1930's and 1940's. Since 1950, doctors have used ECT almost exclusively.

When doctors first used insulin to produce unconsciousness, they hoped it would cure schizophrenia. But the treatment helped only in some cases, and it often produced only temporary improvement. For these reasons, and because it is difficult to administer the treatment safely, it is not often used today.

Electroconvulsive therapy was introduced a few years after insulin treatment. ECT produces convulsions, or seizures, in a patient. The simplest and most common method of administering ECT consists of passing an electric current through the patient's brain for a fraction of a second.

Although ECT is simple to administer, it must be adjusted to each individual case. The number of treatments varies, but most patients receive about three a week, with a total of 6 to 10 treatments over a two- to three-week period. Doctors determine the amount

and the duration of the electric shock by monitoring the patient's brain waves to be sure that a seizure is produced. Pretreatment medications and general anaesthesia are usually given so that the patient experiences no discomfort and neither feels the electric current nor consciously experiences the seizure.

The most important use of ECT is to treat hospitalized patients who remain severely depressed and suicidal in spite of drug treatment and psychotherapy. ECT frequently restores these depressed patients to a normal mental state. The reasons it does so are unknown.

ECT is controversial because it has sometimes been used as a punishment to control violent or uncooperative psychiatric patients. In addition, ECT often causes temporary amnesia, and some doctors claim that it also produces long-term memory loss.

See also **Mental illness** (Electroconvulsive therapy).

Shock wave. See **Aerodynamics** (Shock waves).

Shoe is an outer covering for the foot. Shoes have a sole, and most shoes also have a heel. The upper part of most shoes extends no higher than the ankle. Boots are footwear that reach beyond the ankle. People wear shoes to protect their feet from cold weather, sharp objects, and uncomfortable surfaces.

Shoes are also an important part of people's clothing. As a result, fashion often determines the style of shoes that individuals wear. The desire to be fashionable has led to many unusual shoe styles.

Most shoes are made of leather. But many other materials may be used, including canvas, velvet, and such synthetic substances as plastics. Shoe materials and styles vary somewhat, depending on climate, custom, or other differences. For example, farmers in the Netherlands often wear heavy wooden shoes that protect their feet from the damp ground. Many Japanese wear shoes outside their home but prefer soft slippers at home. People in some regions often wear foot coverings other than shoes. They may wear sandals during the hot summer and switch to warm boots for the cold winter.

Kinds of shoes. There are four main kinds of shoes,

depending on their use: (1) casual, fashion, and dress shoes, (2) sports shoes, (3) work shoes, and (4) corrective shoes.

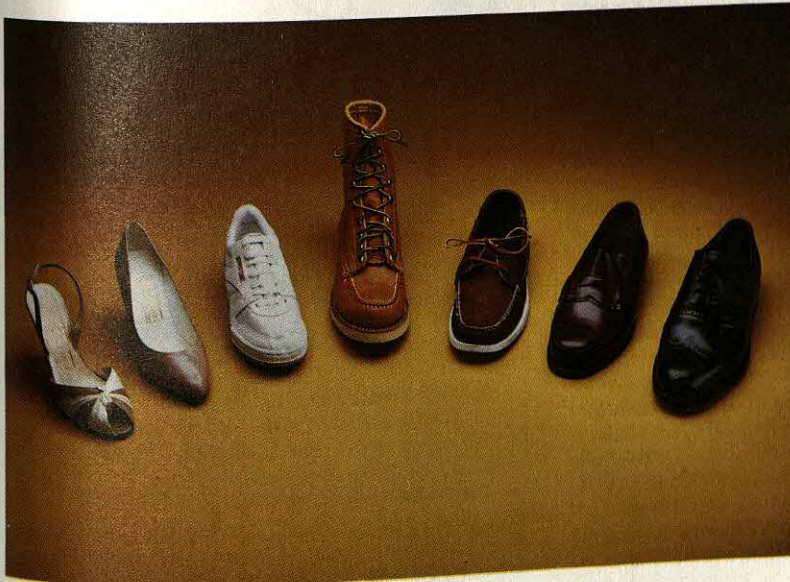
Casual, fashion, and dress shoes are made for almost all everyday occasions. Most casual shoes are based on such low-heeled styles as the slip-on, moccasin, and brogue. Brogues feature a lacing up over a tongue. Moccasins, and slip-ons are shoes that have no lace or tongue.

Most fashion shoes for women are based on the court shoe or sandal style and have high or medium heels. Materials used for these shoes include brocade, satin, silk, tapestry, and velvet. Most men's dress shoes are lace-ups and are made of leather or *patent leather* (leather with a glossy finish).

Sports shoes have different features for various sports. Tennis shoes and trainers have rubber soles that keep the player from slipping. They also prevent the shoes from damaging the playing surface. Some running, golf, and cricket shoes have metal spikes in the soles. Football boots have metal, plastic, or rubber studs.

Work shoes are worn for safety and comfort in many kinds of jobs. Most types of work shoes are sturdy and long wearing and are made of leather. Workers in some factories wear shoes equipped with a steel section inside the toe for protection against injury. People in many trades require shoes especially designed to prevent slipping. Many postal-workers, nurses, restaurant workers, and others who must stand or walk for long periods wear shoes that have a cushioned sole.

Corrective shoes are designed to provide relief from such foot conditions as bunions and corns (see **Bunion**; **Corn**). They also are used for *hammertoes* (toes bent in the form of a claw) and other disorders. Some corrective shoes are ready-made products that have built-in corrections for the most common foot problems. For example, one style features a special heel that supports the *arch*, the curved part of the sole of the foot. Other corrective shoes are specially made for one person, some



Shoes are manufactured in a variety of styles. This picture shows some of the most popular kinds of footwear. They are, from left to right, a dress sandal, a court shoe, a tennis shoe, a boot, a moccasin lace-up, a slip-on, and a brogue.



A shoemaker in the Netherlands is expert at handcrafting wooden shoes called *clogs*. He uses a special tool to hollow out the inside of a clog.

according to a doctor's prescription. Special shoes can sometimes be made to fit the exact shape of the feet—including any corns or other bulges. Such shoes reduce the pressure against these areas.

Shoe manufacturing requires dozens of operations, many of which are highly skilled. First a shoe designer, who generally works for a footwear manufacturer, makes sketches of various ideas and decides what colours and materials will be used. The manufacturer produces samples of the shoes, and sales representatives show the samples to buyers from shoe and department stores. The buyers order shoes from the manufacturer.

At the shoe factory, workers make patterns for each component of each size shoe to be manufactured. Using the patterns, other workers cut sections that will form the *upper* (upper part) of the shoe. The sections of the upper are then joined together by stitching or cementing. Next the upper is placed on a *last* (a plastic form in the approximate shape of a foot) and then moulded to the shape of the last on a *lasting machine*. The sole of the shoe is then attached to the upper by stitching or cementing. Finally, the heel is attached and various finishing operations are carried out.

Shoes and health. Shoes that have been poorly fitted can cause such problems as backache, sore muscles, fatigue, and poor posture. Shoes that are too tight may result in bunions, corns, hammertoes, and ingrowing toenails. Such problems can be avoided by taking care when buying shoes, especially children's shoes. Most children outgrow shoes within a few months.

Shoes should have a space of 15 to 20 millimetres between the tip of the big toe and the shoe. Most people have one foot larger than the other, and so both feet should be fitted. A person should walk around while trying on new shoes to ensure a comfortable fit.

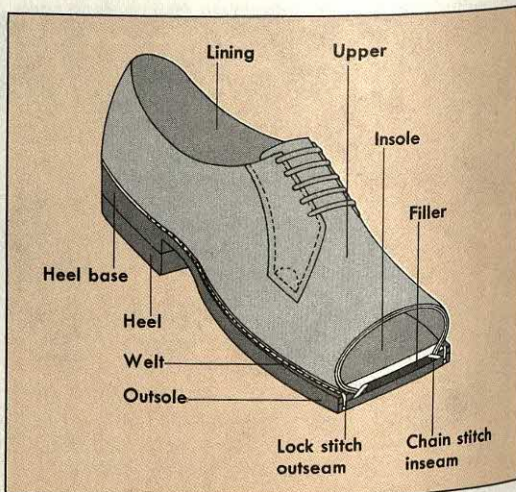
Some people wear certain fashionable shoes even though these shoes are uncomfortable and can hurt the feet. For example, heels higher than 5 centimetres cramp the toes by pushing the feet forward. Pointed shoes also crowd the toes. Shoes with hard, high soles can prevent flexible movement of the feet. Hot feet can result from shoes that do not *breathe* (allow foot moisture to escape). Most shoes made of a synthetic material do not breathe as well as leather ones.

History. No one knows when people first began to wear shoes. The first foot coverings worn in cold regions were probably baglike wrappings made of animal fur. The first known footwear used in warm surroundings consisted of sandals made of plant fibres or leather. The ancient Egyptians wore such sandals as early as 3700 B.C., and the ancient Greeks and Romans also wore sandals. Those three peoples also wore soft leather shoes occasionally. In China, people wore wooden-soled shoes and cloth shoes thousands of years ago.

Throughout history, shoes have been worn not only for protection but also for decoration and to indicate social status. Shoe styles have gone in and out of fashion, just as they do today. For example, the fashion in women's shoes changed to rounded toes in the 1500's, low heels by the late 1500's, and high heels in the 1600's.

Until the mid-1800's, despite the many changes in shoe styles, shoemaking itself involved chiefly the use of simple hand tools. Most people wore homemade shoes or bought shoes from a shoemaker who lived nearby or travelled from house to house. Improved sewing machines were developed in the mid-1800's, and shoemaking became a factory operation. These machines had special devices to stitch shoe parts that previously had required nailing or stitching by hand.

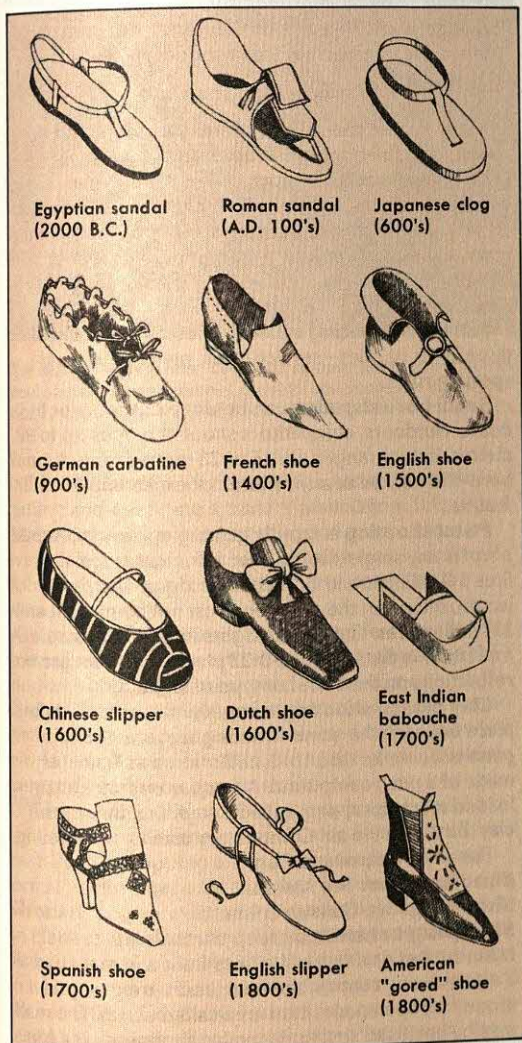
In 1882, Jan Ernst Matzeliger, a worker in an American



The parts of a shoe are put together at a shoe factory. The sections of the upper part of the shoe are sewed together and then fastened to the sole.

Some shoes of the past

Throughout history, fashion has often determined the style of men's and women's shoes. The desire of people to be fashionable has led to many unusual kinds of shoes.



shoe factory, invented the shoe-lasting machine. This and other new shoemaking machines led to the mass production of shoes by 1900. The mass production of footwear brought a great reduction in the price of these products. Today, many shoe-manufacturing operations are automated. Shoes may be designed on a computer. Components may be cut by a laser and stitched by computer-controlled stitchers. Such improvements enable manufacturers to respond to style changes quickly.

See also **Leather; Moccasin; Wooden shoe.**

Shoebill is a large bird that many scientists believe is related to the stork. It is sometimes called *whale-headed stork*. Shoebills live in Africa on marshes from the Upper Nile to Uganda and Congo. The bird stands up to 1.2 metres tall. It is ash-grey in colour and gets its name from its enormous bill. When disturbed, it snaps its bill

open and shut rapidly, making a loud rattling sound.

The shoebill has long legs. It wades in shallow water, where it feeds on fish. It uses its huge bill to dig African lungfish out of the mud in the dry season. The shoebill flies with its neck in the shape of an S, its long legs trailing behind. Shoebills live in pairs. They nest on the ground where they build a large platform of reeds lined with grass. The female bird lays one or two rough-shelled white eggs.

Scientific classification.

The shoebill makes up the shoebill family, Balaenicipitidae. It is *Balaeniceps rex*.

See also **Bird** (picture: Birds of Africa).

Shoemaker, Bill (1931-), an American jockey, ranks among the greatest jockeys in the United States. By the time he retired in 1990, Shoemaker had ridden 8,833 winners in 40,350 races and had won prize money totalling over 120 million U.S. dollars. Shoemaker rode the winning horse in the Kentucky Derby in 1955, 1959, 1965, and 1986. Billie Lee Shoemaker was born in Fabens, Texas. He became a jockey in 1949.

Shogun was the title of the greatest of the Japanese feudal lords. The term *shogun* means *great general* in Japanese, and is an abbreviation of a title meaning *Barbarian-Subduing Generalissimo*. This official had originally received emergency military powers from the Japanese emperor to fight against the Ainu tribe in the A.D. 800's. After 1192 the power of the imperial court decreased, and the shogun also assumed civil power. In theory, the emperor appointed each new shogun, but the shogun was the real ruler of Japan. The Minamoto, the Ashikaga, and the Tokugawa families carried the shogun title. The shogun's power reached its peak under the Tokugawa family, from about 1600 to 1867. In 1867, the shogun resigned and returned his powers to the emperor.

See also **Japan** (Rise of the shoguns); **Samurai.**

Sholes, Christopher Latham (1819-1890), an American inventor and journalist, helped develop the first practical typewriter. Sholes, Carlos Glidden, and Samuel W. Soule designed the typewriter in 1867 and patented it in 1868. Glidden and Soule sold their interests to Sholes and his new partner, James Densmore. They began to manufacture the machine but were unable to make and sell it. In 1873, Sholes and Densmore gave E. Remington and Sons a contract to make it. Sholes later sold most of his interests in the typewriter. Sholes was born near Danville, Pennsylvania. He was a successful Wisconsin newspaper editor and served in the Wisconsin state legislature. Sholes and Soule invented a page-numbering machine in 1866. See also **Typewriter** (History; pictures).

Sholokhov, Mikhail (1905-1984), was a Soviet writer. He received the Nobel Prize for literature in 1965.



Shoebill

Mikhail Alexandrovich Sholokhov was born in Veshenskaya, a Cossack village on the Don River in southwestern Russia. He won fame for his novels and stories describing the life and people of his native region.

Sholokhov's best-known work is the four-volume historical novel *Quiet flows the Don* (1928-1940). This epic story describes the effects of the Russian Revolution of 1917, and of the civil war that followed, on the lives of the Don Cossacks. Sholokhov also wrote *Virgin Soil Upturned* (1932, 1955-1960), a two-volume novel about the problems of Don Cossacks living on collective farms. Sholokhov's early works include the short-story collections *Tales of the Don* (1925) and *The Azure Steppe* (1926).

See also **Russian literature** (The period of socialist realism).

Sholom Aleichem (1859-1916) was the pen name of Solomon Rabinowitz, the most widely read of all Yiddish writers. He wrote humorous short stories, novels, and plays about life in the *Pale of Settlement*. The Pale of Settlement was an area in western Russia where until 1917 Russian Jews were required to live. Sholom Aleichem's works also deal with Jewish immigration to the United States. His technique of "laughter through tears" emphasized the dignity, generosity, and shrewd self-appraisal of his poverty-stricken characters. Major works include the four series of stories *Menakhem-Mendl* (1892), *Motl the Cantor's Son* (1907), *The Railroad Stories* (1911), and *Tevye the Dairyman* (1911). His best-known play, *It's Hard to Be a Jew*, was written in 1914. Sholom Aleichem was born near Kiev, Russia, and migrated to the United States in 1914.

Shooting is a popular sport in many countries. People interested in shooting may enjoy game shooting or competition shooting. Usually, a licence is necessary to carry or use a shotgun and another to shoot game.

Game shooting

Shooting seasons. In many countries, strict laws govern the times of the year during which birds and animals may be shot. Periods when shooting is not allowed are called *close seasons*, and differ for the various species. Periods when shooting is allowed are called *open seasons*. Without a close season, most species of game

would be extinct within a few years. In some areas, called *game preserves*, shooting is entirely prohibited, except that gamekeepers are allowed to control vermin birds. These birds steal large numbers of eggs and kill young game birds and songbirds.

Shotguns are the traditional guns for shooting game. Hunters use them mainly for shooting at birds in flight.

Competition shooting

Many people take a keen interest in competition shooting. In full-bore, small-bore, and pistol shooting, a competitor shoots at a paper target, divided into four concentric circles, each of which counts for a different score. From the centre out they are: *bull's-eye*, 5 points; *inner*, 4 points; *magpie*, 3 points; and *outer*, 2 points. In clay pigeon shooting, a competitor uses a shotgun to shoot at a clay disc that is moving through the air.

Full-bore shooting includes shooting with any of three kinds of rifles—service rifles, match rifles, and sporting rifles.

Small-bore shooting can be done outdoors or indoors. Outdoors, competitors shoot at ranges up to 90 metres. Indoor ranges are 14 or 23 metres long. A small-bore rifle may be of any calibre not exceeding 5.5 millimetres.

Pistol shooting is rapidly gaining popularity. A *0.22 pistol* is any single-shot or semiautomatic pistol that fires 5.6-millimetre (0.22-inch) cartridges. The barrel length, including the cylinder, must not be more than 254 millimetres. The pistol's sights may be adjustable. A *free pistol* is the same as a 0.22 pistol, but there are no restrictions on the barrel or type of sight.

Clay pigeon shooting competitions normally take place between the game-shooting seasons. A *clay pigeon* is a circular disc 101.5 millimetres in diameter made of a pitch compound. A *trapper* operates a spring-loaded mechanical arm, called a *trap*, that throws the clay "bird" into the air. Competitors take turns shooting.

See also **Firearm and Gun**.

Shooting star. See **Meteor**.

Shopping. See **Consumerism**.

Shopping centre is a group of retail outlets and business and professional offices built and managed as a unit. In many centres, the businesses are grouped around an open pedestrian area called a *mall*. The mall may be enclosed so that the entire shopping area can be heated and air-conditioned. Such a mall allows people to shop in comfort in any kind of weather. In many large centres, the mall is designed as an attractive park. A large centre includes many facilities of a small city, such as art galleries, banks, hotels, medical clinics, a post office, restaurants, sports facilities, and theatres. Some centres even include churches and flats. Such centres resemble a shopping town more than just a shopping centre.

In most centres, the traders pay rent to a single firm that owns the centre. The owner, in turn, seeks to attract people to the centre to create a busy market setting for the tenants. First, the owner chooses a site convenient to the public and builds attractive facilities with an ample parking area. The owner then leases space to a carefully balanced selection of competitive shops that will have maximum appeal to the public. After the centre opens, the owner provides for cleaning, maintenance, security,



In small-bore competition shooting, competitors at major events usually fire at circular, bullseye targets from three different positions—standing, lying, and kneeling.



The mall of a shopping centre is an open area surrounded by retail shops. In many centres, the mall and shops are under one roof. Fountains and trees add beauty to the mall.

and fire protection. The owner also assists the traders in staffing and operating a traders' association. This organization plans and publicizes sales and promotional events. For example, the businessmen may sponsor fashion shows, concerts, and other events that take place in the mall.

Marketplaces that lease space to traders have existed in many parts of the world since ancient times. But the modern shopping centre, which was designed with the car in mind, was developed in the United States. Fewer than a dozen shopping centres existed in the U.S., when World War II ended in 1945. But after the war, the idea caught on and soon spread worldwide.

The growth in the number of shopping centres has resulted in the decline in importance of many traditional town centre shopping areas where shops have been forced to close because of lack of business.

Shoran, an abbreviation for *short range navigation*, is an electronic system used for short-range aerial navigation. An aeroplane using shoran sends out radio signals to two ground stations, which rebroadcast the signals to the aeroplane. Electronic instruments record the time interval between sending and receiving the signals. Shoran calculates the distance to the stations by means of these intervals. Shoran was developed during World War II by the U.S. Army Air Forces and private industry. See also **Loran**; **Navigation**.

Short story is a work of fiction that is shorter than a novel or novelette. Most can be read at one sitting.

The short story is one of the oldest forms of literature. As early as 3000 B.C., brief fictional tales were written down in Egypt. Other examples of the short story form are the tales from the *Arabian Nights*. The Bible contains short stories called *parables*, which try to teach moral lessons.

Some of the most famous short stories ever written make up two collections that appeared late in the Middle Ages. The *Decameron* (about 1349-1353) is a collection of 100 tales by Giovanni Boccaccio, an Italian writer. The *Canterbury Tales* (about 1385-1400) is a book of 24 stories by Geoffrey Chaucer, an English poet.

During the 1800's, many writers began to consider the short story as a separate form of literature. Edgar Allan Poe, an American author and literary critic, was perhaps the first important writer to analyse short stories as a distinct literary form. In some of his writings, Poe discussed the dramatic effects, such as fear and surprise, that could be achieved in a short story. The first book about short-story writing was *The Philosophy of the Short-Story* (1901) by Brander Matthews, an American critic. This book contained many of Poe's ideas.

Short-story writers have developed a number of literary techniques, including the *surprise ending* and *epiphany*. Most surprise endings involve an unexpected event or a revealing explanation. Such endings were the speciality of O. Henry, an American short-story writer of the late 1800's and early 1900's. He used surprise endings in "The Furnished Room" (1904), "The Gift of the Magi" (1905), and many other tales. Epiphany is a sudden comment, incident, or symbol that can be used at any point in a story to explain the meaning of a complex event. James Joyce, an Irish author of the early 1900's, created this technique. He included it in a collection of short stories called *Dubliners* (1914).

Writers of short stories have also used various approaches in their works. For example, some authors concentrate on the events of ordinary life instead of emphasizing dramatic action. Anton Chekhov, a Russian writer of the 1800's, used such an approach in many stories, including "The Party" (1888) and "The Lady and the Dog" (1899). A number of later writers followed Chekhov's style, including the New Zealand author Katherine Mansfield and the American authors John O'Hara and John Updike.

See also **Boccaccio, Giovanni**; **Canterbury Tales**; **Chaucer Geoffrey**; **Chekhov, Anton P.**; **Henry, O.**; **Parable**; **Poe, Edgar Allan**.

Short ton. See **Ton**.

Short waves are radio waves that have wavelengths shorter than those of waves used in medium wave broadcast transmissions. The wavelength of a wave is the distance between successive repeated patterns of the wave. Wavelength is related to frequency. As frequency increases, wavelength decreases. Short waves have frequencies higher than 1.6 *megahertz*—the upper limit of the medium-wave broadcast band and amplitude modulation (AM). One megahertz (MHz) equals 1 million *hertz* (cycles per second).

Short waves carry frequency modulation (FM) radio broadcasts, television signals, and transoceanic telephone conversations, teletype messages, and information for shipping and aeroplane pilots. Short-wave radios are used by aeroplane pilots, amateur radio operators, ships, the military, and others to send and receive messages.

Short-wave frequencies are divided into several bands. The *medium frequency* band includes short waves with frequencies up to 3 MHz. The *high frequency* band ranges from 3 to 30 MHz; the *very high frequency* band, from 30 to 300 MHz; and the *ultrahigh frequency* band, from 300 to 3,000 MHz (see **Very high frequency waves**; **Ultrahigh frequency waves**).

See also **Microwave**; **Radio**; **Amateur**.

Shortening. See **Butter**; **Lard**; **Margarine**; **Vegetable oil**.

Shorthand is a method of writing rapidly, using symbols or letters to represent the sounds of words. In shorthand, a person writes only what he or she actually hears, regardless of the spelling of a word. For example, the word *people* becomes *pepl* in shorthand. Other short cuts include using a symbol or a combination of symbols or letters to represent whole words or entire phrases of several words.

Shorthand is used chiefly to take dictation. Most people speak at a rate of about 140 words a minute. But a shorthand typist can take most dictation by writing shorthand at a rate of 80 words a minute. Some shorthand typists, however, are required to reach speeds of 120 or more words a minute. Court reporters must be able to take down conversation at a rate of at least 200 words a minute. The world record for writing shorthand in a contest is held by Martin Dupraw, an American court reporter. In 1927, using the Gregg method of shorthand, Dupraw took down testimony at a rate of 282 words a minute for five minutes.

Hundreds of shorthand systems have been developed. The *Gregg* and *Pitman* methods are the best-known systems using symbols. The *Thomas Natural* system, a newer method, is not used so much as the others. *Speedwriting* is the most common of the shorthand systems that use longhand letters instead of symbols (see *Speedwriting*). Several shorthand machines have also been developed. The *Stenograph* is one of the most widely used of these machines.

Gregg shorthand

The Gregg method was invented by John Robert Gregg, an educator born in Ireland. It is the most widely used shorthand system in the world. Gregg published his first book, *Light-Line Phonography*, in England in 1888. He later promoted his system in the United States. The symbols in the Gregg system are based on longhand strokes and flow along in the same smooth style as longhand writing.

Consonants. Many characters representing consonants in the Gregg system appear in pairs and differ only in length.

Written forward:

K G R L N M
T D Th H (dot)

Written downward:

P B F V S and Z
Sh Ch J Ng Nk

Vowels. A large circle, O, is used to represent the sounds of the vowel *a*: ä as in *cat*; ä as in *calm*; ä as in *cane*.

A small circle, o, is used for the following sounds: *y* as in *hit*, *e* as in *hen*, and *ë* as in *greet*.

A hook, u, is used to indicate the following sounds: *ö* as in *rot*, *aw* as in *raw* and *bought*, and *ö* as in *wrote*.

Diphthongs:

ü as in *few* oi as in *oil*
ow as in *cow* ī as in *die*

Punctuation:

Full stop Question mark Dash
Hyphen Paragraph Parenthesis

A different hook, w, is used for these sounds: *ü* as in *duck*; *oo* as in *took*; *oo* as in *pool*.

Brief forms. A person studying the Diamond Jubilee Edition of Gregg shorthand learns the symbols and memorizes 129 *brief forms* that represent common words. Examples of the most frequently used symbols are illustrated in the chart below.

can	be, by
good	but
are, our, hour	have
in, not	could
am	should
at, it	with
the	

Phrasing. All shorthand systems include many standard phrases. Most students learn these phrases from a textbook. Most writers also work out their own phrases for expressions used often by their employer.

Examples of phrases:

in the	could be
at the	should be able

Phrases omitting unimportant words:

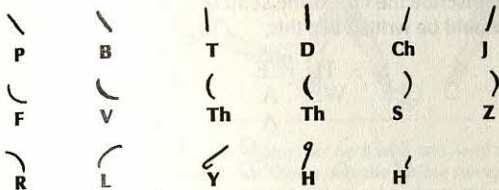
at a loss	two or three
one of the	some of our

Pitman shorthand

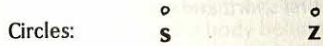
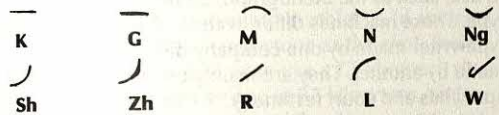
The Pitman method was invented by Isaac Pitman, an Englishman, in the 1830's. His first shorthand book was published in England in 1837. Pitman shorthand is characterized by the shading of strokes. Some strokes are light and others are heavy or dark. In Pitman shorthand, the position of the symbol *above*, *on*, or *through* the line further determines the meaning of the word.

Consonants. Many similar-sounding consonants are represented by the same symbol. The shading of the symbol indicates differences in sound.

Written downward:



Written forward:



Vowels. When the first vowel in a word has the sound of ä, ah, ö, or aw, the outline is written *above* the line. When the first vowel has the sound of ë, ä, ü, or ö, the outline is written *on* the line. When the first vowel has the sound of i, e, ö, or oo, the outline is generally written *through* the line. But there are some exceptions to this rule for writing outlines through the line.

When placed near the beginning of a consonant stroke, a light dot expresses the sound of ä as in *sat*, a heavy dot expresses the sound of ah as in *car*, a light dash expresses the sound of ö as in *got*, and a heavy dash expresses the sound of aw as in *talk*.

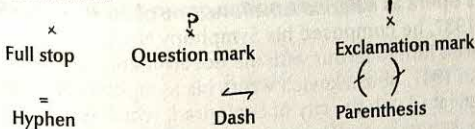
When placed close to the middle of a consonant stroke, a light dot expresses the sound of ë as in *get*, a heavy dot expresses the sound of ä as in *mate*, a light dash expresses the sound of ü as in *trust*, and a heavy dash expresses the sound of ö as in *low*.

When placed close to the end of a stroke, the sound of i as in *sit* is shown by a light dot, the sound of ë as in *tea* by a heavy dot, the sound of ö as in *foot* by a light dash, and ö as in *food* by a heavy dash.

Diphthongs:



Punctuation:



Short forms. Pitman shorthand has 204 *short forms*. Like the Gregg brief forms, these represent frequently used words and phrases.

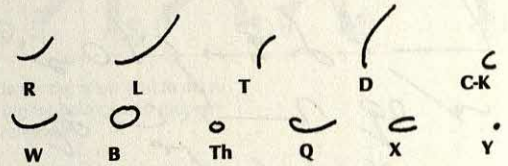
Thomas Natural shorthand

The Thomas Natural system was invented in the 1930's by Charles A. Thomas, an American shorthand teacher.

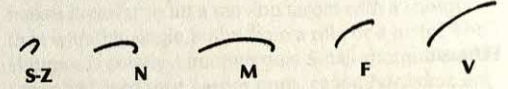
Thomas' first textbook appeared in 1935. It was designed to provide a simpler symbol system. However, the Thomas Natural system never became widely used. It has only 12 word forms. They correspond to brief forms and short forms. Other words may be shortened by writing the first consonant and other major sounds.

Consonants have definite symbols.

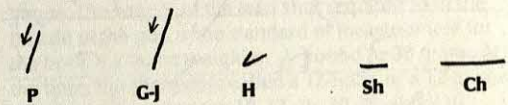
Written anticlockwise:



Written clockwise:



Straight-line strokes:

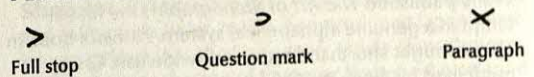


Vowels. The vowel following the first consonant of a word is expressed automatically by simply placing the base of the consonant stroke *above* the line to express *a*, *on* the line to express *e* and short *i*, and *below* the line to express *o*, *oo*, and *u*. Vowels at the beginning of words are expressed in the following manner:

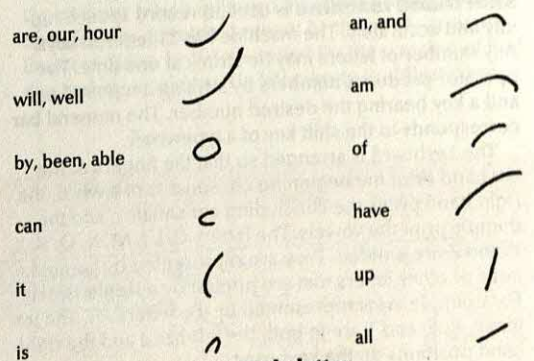


(Long *i* is always written in this manner.)

Punctuation:



Word signs. These are the 12 memory forms:



A sample letter

Here is a letter written in the two leading systems of symbol shorthand.

Gentlemen:

The back issue of your publication, which I recently requested, arrived this morning. Please accept my thanks for your promptness.

Cordially yours,

Gregg:

Pitman:

J:

History

Marcus Tullius Tiro, a secretary to the Roman orator Cicero, invented a shorthand system about 50 B.C. The art of shorthand was revived in England in 1588, when Timothy Bright published his *Characterie: an Art of Short, Swift, and Secret Writing by Character*. This was followed by Peter Bale's *Brachygraphy*. In 1602, John Willis published *The Art of Stenography*, the first attempt at a genuine alphabetical system. Pitman's book in 1837 brought shorthand into worldwide use. Gregg published his book in 1888.

See also Gregg, John R.; Pitman, Sir Isaac; Shorthand machine; Speedwriting.

Shorthand machine is used to record speech rapidly and accurately. The machine has 21 lettered keys. Any number of letters may be struck at one time. The operator produces numbers by striking a numeral bar and a key bearing the desired number. The numeral bar corresponds to the shift key of a typewriter.

The keyboard is arranged so that the fingers of the left hand print the beginning consonants of a word, the right hand prints the concluding consonants, and the thumbs print the vowels. The letters C, I, J, M, N, Q, V, X, Y, and Z are omitted. They are represented by combinations of other letters that are printed by a single stroke. For example, *M* is represented by the letters *PH*. The letters P, R, S, and T are in both the left-hand and the right-hand positions on the keyboard.

A shorthand machine operator writes by sounds, much like writers using other shorthand systems. Thus, the operator omits all letters of a word that are not actu-

ally pronounced. Many words and phrases can be written with single strokes. The operator writes multistroke words one syllable at a time. The letters are printed on a narrow paper pad that moves automatically, a line with each stroke. Anyone familiar with this method can easily transcribe the notes. The sentence *She was at our house* would be written like this:

S H E S
W A T
A O U R
H O U S

There are several different types of shorthand machines in use, such as the Stenograph, Stenotype, and Brevitype. These machines differ in about the same way that a typewriter made by one company differs from one made by another. They are mainly used for recording speeches and court testimony.

Ward Stone Ireland, a court reporter from Texas, U.S.A., invented the first shorthand machine, the Stenotype, in 1910.

See also Shorthand.

Shortwall mine. See Coal (The longwall system).

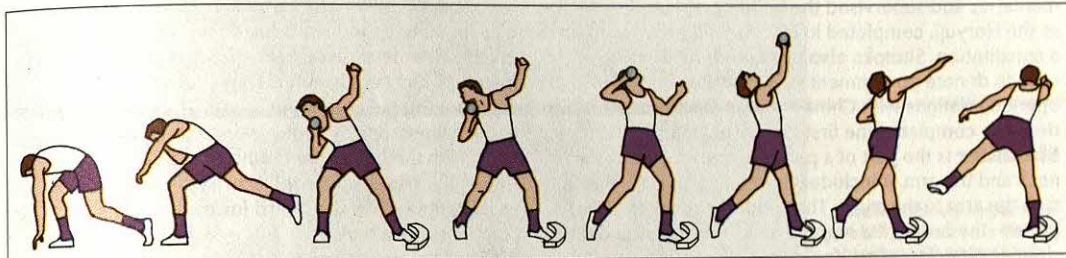
Shostakovich, Dimitri (1906-1975), was the most important Russian composer whose musical education and career took place entirely in the Soviet Union (see **Union of Soviet Socialist Republics**). His major works are 15 symphonies and 15 string quartets. He also wrote concertos, songs, film scores, ballets, and operas. His most popular compositions include the lively "Polka" from the ballet *The Golden Age* (1930).

Shostakovich based his musical style on the Russian nationalism of the 1800's demonstrated by composer Peter Ilich Tchaikovsky and a group of Russian composers known as The Five. Shostakovich also added influences from Western music. His monumental symphonies owe much to the late romantic symphonic style of the Viennese composer Gustav Mahler. Shostakovich added his own wit and humour, rhythmic vitality, mastery of the orchestra, and intensity of expression.

Dimitri Dimitrievich Shostakovich was born in St. Petersburg (later called Petrograd and then Leningrad). He entered the Petrograd Conservatory in 1919, two years after the Soviet Revolution in Russia. For his graduation, he wrote his Symphony No. 1 (1925), which won international acclaim. By the early 1930's, he was writing in a style that authorities eventually declared unacceptable for a Soviet composer. In 1936, they denounced his opera *Lady Macbeth of Mtsensk* (1932) as "chaos instead of music." Between 1956 and 1963, Shostakovich revised this opera as *Katerina Ismailova*, one of his finest works. In 1937, he composed his Symphony No. 5, which restored him to favour with the government.

In 1941, Shostakovich wrote his Symphony No. 7. He dedicated it to the city of Leningrad, which was being blockaded by the Germans during World War II. In 1948, the government again censured Shostakovich's music, along with works by other leading Soviet composers. After the death of Soviet dictator Joseph Stalin in 1953, Shostakovich felt more at liberty to compose as he pleased. Several of his late large-scale works reflect Russian history in the 1900's.

Shot. See Shot tower; Shotgun.



A shot-putter holds the shot against his neck with one hand and extends the other arm to maintain balance. The drawing above shows how the athlete swings one leg for balance and momentum. Then, after gliding across the ring, he pushes the shot away to release it.

Shot-put is a test of strength in athletics. In ancient times, athletes used a heavy stone as the *shot*. Today, athletes use a metal ball. Men use a 7.5-kilogram shot, high-school athletes use one of 5.5 kilograms, and women use one that weighs 4 kilograms.

Success in shot-putting depends upon ability to get the whole force of the body behind the heave. The put is made from a circle 2.1 metres in diameter. An arc-shaped wooden stopboard forms the front of the circle.

Most shot-putters use either the *glide* or the *spin* technique. Every thrower starts at the back of the circle facing the back. The thrower balances the shot in the hand, cradling it against the neck. In the glide, he or she then hops, or glides, toward the front of the circle as the body turns until the leading foot is near the stopboard. As the athlete propels the shot, the arm thrusts out in a long follow-through. In the spin, the thrower turns or spins to gain momentum, rotating $1\frac{1}{2}$ times as he or she steps toward the front of the circle. While completing a turn near the front of the circle, the thrower pushes the shot out. The measurement of the put is made from the nearest edge of the first break of ground to the nearest point on the inside edge of the shot-put circle.

For shot-put championship figures, see the *tables* with *Athletics and Olympic Games*.

Shot tower is a structure used to make small shot for firearms. In the past, shot towers were wooden or brick towers 15 to 30 metres high. People poured melted lead through a vessel with holes in it at the top of the tower. As each piece of lead dropped, it formed a round ball. It cooled in this shape when it landed at the bottom in a vessel containing cold water. Today, most shot is made in towers that are up to 58 metres high.

Shotgun is a shoulder gun that fires a cartridge that contains a powder charge and a load of metal pellets,

called *shot*. The shot spreads over a wide area. This makes it easier to hit a moving target with a shotgun than with the single bullet from a rifle or a pistol. The shotgun is chiefly a hunting gun. Small shotgun pellets are called *bird shot*. Larger ones, called *buckshot*, are used to shoot such animals as deer.

The calibre of a shotgun is measured by *bore*, or *gauge*. The weight of the lead shot required to fit the muzzle of the gun is the standard of measurement for the bore. If a bullet weighing $\frac{1}{2}$ pound or 38 grams fits the bore, the shotgun is called a 12-bore, or a 12-gauge, gun. Popular gauges are 10, 12, 16, 20, 28, and .410.

The amount of spread in the shot is controlled by the *choke*. If a barrel will put 70 per cent of its shot charge in a 76-centimetre circle at 37 metres, it is called *full choke*. *Modified choke* will deliver about 60 per cent; *improved cylinder* about 50 per cent. A full choke 12-gauge gun can kill birds 55 to 60 metres away.

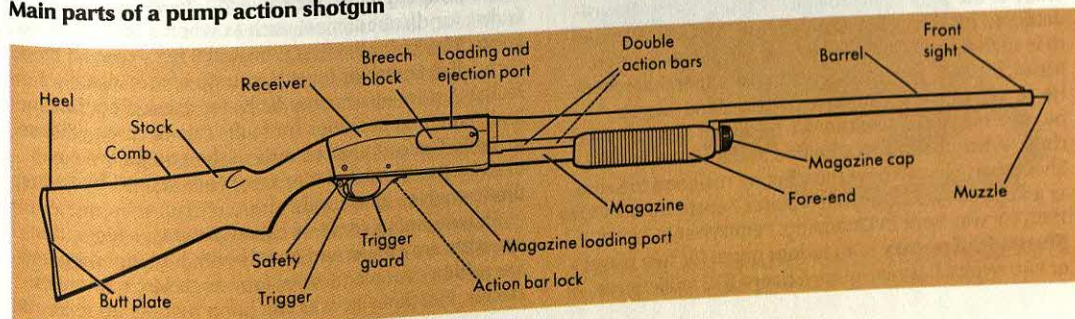
The first shotgun, developed in 1537, was loaded with small shot instead of one round ball. In 1831, Augustus Demondion patented a cartridge that held small shot. Modern shotguns are single barrels, double barrels, or single barrels with automatic repeating magazines that hold several cartridges.

See also *Ammunition* (with diagram); *Skeet*.

Shotoku, Prince (573-621), was a Japanese statesman and religious scholar. In 604, he introduced Japan's first known written law, the Seventeen Article Constitution.

Shotoku was the son of Emperor Yomei, who reigned from 585 to 587. While very young Shotoku became a wise, successful student. At the age of 15, he fought in the civil war which followed his father's death. In 592, Shotoku was appointed regent by the newly-crowned Empress Suiko. In 594, he called for the worship of Buddha and his teachings. He later wrote Buddhist com-

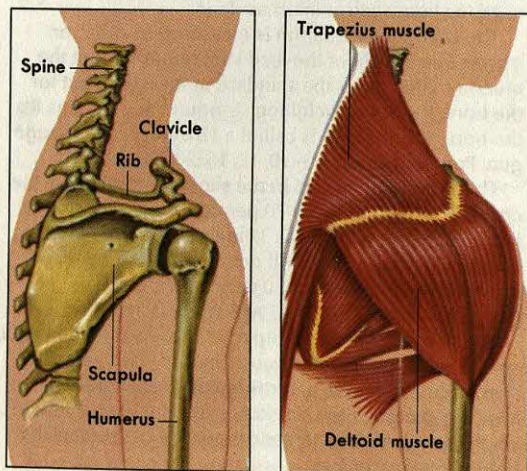
Main parts of a pump action shotgun



mentaries and supervised the building of temples, such as the Horyuji, completed in 607. As well as drawing up a constitution, Shotoku also promoted the wearing of caps to denote government rank. Shotoku formally opened relations with China in 607. A year before his death he completed the first history of Japan.

Shoulder is the part of a person's body between the neck and the arm. It includes bones and muscles that attach the arm to the trunk. The shoulder consists of two bones—the broad, flat *scapula* (shoulder blade) and the slender *clavicle* (collarbone). The largest muscle of the shoulder, the *deltoid* muscle, raises the upper arm.

Joints in the shoulder enable the upper arm to move. The *humerus* (bone of the upper arm) has a round head that fits into a shallow depression of the scapula, forming the shoulder joint. Near the tip of the shoulder, a joint formed by the clavicle and the scapula permits the scapula to twist. Such twisting allows greater arm motion than would the shoulder joint alone.



The shoulder consists of two bones, the *clavicle* and *scapula*, left, and various muscles, right. The *humerus*, the upper arm bone, forms a ball-and-socket joint with the scapula. The *deltoid* muscle, one of the largest shoulder muscles, helps move the upper arm. The *trapezius* muscle helps rotate the scapula.

The shoulder joint can be dislocated more easily than any other joint. A fall on an outstretched arm, or a hard push from behind, can cause a dislocated shoulder. Many athletes suffer this injury.

See also *Collarbone; Joint; Human body* (picture).

Shoup, George Laird (1836-1904), was the first governor of the state of Idaho in the United States. He volunteered for the Union Army during the Civil War, and rose to the rank of colonel. He helped found Salmon, Idaho, in 1866, and was successful as a merchant there. He served in the territorial legislature, and was appointed territorial governor by President Benjamin Harrison. When Idaho was admitted to the Union in 1890, Shoup was elected governor. But he resigned to serve as a Republican in the United States Senate from 1890 to 1901. He was born in Kittanning, Pennsylvania, U.S.A.

Shove-halfpenny is an indoor game for two players or two teams. It is played on a board 610 millimetres

long and 368 millimetres wide. Lines marked at right angles to the two long sides divide it into *beds*. The players use five metal discs, each measuring about 25 millimetres (1 inch) in diameter. They place them overhanging the end of the board. They aim to *fill* all the beds in any order by *shoving* discs three times into each, with the ball of the thumb or the palm of the hand. After each player's turn, the scores are marked with chalk at the side of the board for each disc that is resting completely in a bed.

Shoveler, also called *spoonbill*, is a small duck of the Northern Hemisphere with a long spoon-shaped bill. It lives in Europe, Asia, and North America in summer, and migrates south in winter to North Africa, southern Asia and South America. The upper portion of the bill overhangs the lower. The male has a green head, white breast, and blue-and-chestnut-coloured body. The shoveler feeds in shallow water on molluscs, insects, and roots. It takes a mouthful and strains the mud and water out through "gutters" in the sides of its bill, leaving the food inside. Shovelers nest on the ground, sometimes quite a distance from water. The female lays from 6 to 14 pale-greenish to bluish-white eggs.

Scientific classification. The shoveler belongs to the family Anatidae. It is *Anas clypeata*.

Showjumping is a competitive horseriding sport. In showjumping events, riders compete by riding horses or ponies to jump over specially prepared and varied obstacles. Typical obstacles include gates, fences, parallel bars, and imitation walls. Some showjumping courses include fixed obstacles such as banks, permanent hedges, and a water jump. Two or more obstacles set less than 12 metres apart are called a *combination*. Obstacles have *height* (up to about 1.7 metres) or *spread* (up to about 2.2 metres, except for a water jump, which may be as long as 4.25 metres). Obstacles such as an *oxer* (a combination of hedge and railing) or triple bars have both height and spread. A typical course has 10 or 12 obstacles, but courses for international events may have more.

Courses vary in length from about 250 metres to 650 metres. Often there is a maximum time by which the course must be completed, usually based on speeds of between 300 and 400 metres a minute.

Riders usually compete for prize money, and in local and national contests their horses and ponies are placed in grades based partly on age and height, but mainly on their total winnings in prize money. Most successful showjumping horses are large, and some continue to compete up to the age of 20.

The usual method of scoring (called Table A) is to allocate jumping faults: for knocking down an obstacle (4 faults); for disobedience, such as when a horse refuses a jump (3 faults for the first time and 6 for a second time); for a fall (8 faults); or for water jump errors (usually 4 faults). A rider incurs time faults for exceeding the time limit, and time penalties for faults due to disobedience. In Table C scoring, all rounds of the course are measured by time, and faults or errors are scored by adding time penalties in seconds.

Showjumping contests called *puissance* (power or strength) are concerned mainly with high jumping and are ridden over a course of four or six large single obstacles. Puisseance horses can jump heights up to about 2



Leading showjumpers like John Whitaker of the United Kingdom, *left*, attract large crowds to showjumping events.

metres, and the world record high jump is over 2.4 metres.

There are a number of other special forms of showjumping contests, such as top score, accumulator, double accumulator, power and speed, take your own line, fault and out, six bars, and knock out. Showjumping contests between teams of three or four riders are a feature of some international championships, including the Olympic Games.

Showjumping forms one part of horseriding competitions known as *horse trials*, *three-day events*, or *eventing*. In a three-day event, riders and horses compete in three types of trial over a period of three consecutive days. First is *dressage*, which tests a horse's obedience and response to controls. Second is a *cross-country* trial, which tests a horse's speed and stamina over a difficult course of 16 kilometres or more. The cross-country course includes jumps where refusals and falls incur penalties. Showjumping is the last of the three trials.

Showjumping is particularly popular in Europe, Australia and New Zealand, and North and South America. Some horses are bred specially for the sport. There are many local events, and more than 160 national and international events are held annually in Europe. The sport continues almost throughout the year, because a number of major events take place in covered arenas.

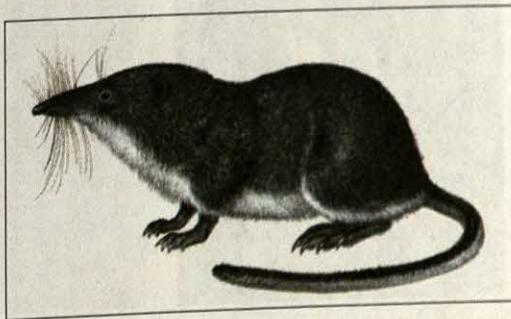
Most showjumping competitions are organized on a national basis by national showjumping associations. Riders join their national association and register their horse or pony with it. The national association maintains lists of horses and riders with details of their current grade and ranking. National associations are affiliated to the *Fédération Equestre Internationale* (International Equestrian Federation), which governs international showjumping events.

Outstanding international showjumping riders include Pierre Durand of France, Thomas Frühman and Hugo Simon of Austria, Anne Kursinski and Leslie Bur-Lenehan of the United States, Eddie Macken of Ireland, Alvin Schockemoehle of Germany, Mark Todd of New Zealand, and John and Michael Whitaker of the United Kingdom.

Shrapnel was a type of artillery shell invented by Lieutenant (later, Lieutenant General) Henry Shrapnel (1761-1842). The shell contained a number of balls and a charge of powder that burst the shell. The British Army used the first shell of this type in Suriname in 1804. During World War I (1914-1918), shrapnel was considered one of the most reliable and effective antipersonnel shells. Since World War II (1939-1945), the word commonly refers to the steel fragments of the shell casing hurled by an explosive charge, though some types of shells filled with metal fragments are still used. See also **Ammunition; Artillery**.

Shrew is a small animal that looks like a sharp-nosed mouse. Some shrews are among the smallest known mammals. The tiniest shrews weigh just two grams. Shrews live in both the Eastern and the Western hemispheres. They make their homes in fields, woodlands, gardens, and marshes.

Shrews are often mistaken for mice because of their small size. Shrews have long, slender snouts which they can move to explore small holes and crevices for food. Their eyes and ears are tiny, and their bodies are covered with short, dark hair. One of the largest shrews is the African forest shrew, which grows up to 29 centimetres. The smallest species, also from Africa, is the pygmy white-toothed shrew, which grows about 4.5 centimetres long.



A shrew is a small animal that resembles a sharp-nosed mouse. Its strong musky odour protects it against enemies.

Shrews eat insects and worms chiefly, but they sometimes kill and eat birds and other small creatures. They even attack mice larger than themselves. They are fierce fighters. The bite of some shrews is poisonous to their prey. Shrews must eat almost continuously during the day in order to satisfy their high energy requirements.

Weasels, foxes, and owls prey upon the shrews. But the shrew's strong musky odour protects it against enemies. Several species of shrews dig burrows. The European water shrew uses burrows to squeeze water from its fur.

Shrews are harmless to human beings. They are useful in gardens, for they eat insects and grubs.

Scientific classification. Shrews belong to the shrew family Soricidae. The African forest shrew is *Crocidura odorata*. The pygmy white-toothed shrew is *Suncus etruscus*, and the European water shrew is *Neomys fodiens*.

See also **Tree shrew**.

Shrewsbury, Battle of (1403), ended the revolt that Sir Henry Percy led to dethrone Henry IV of England. Percy and the Earl of Worcester assembled an army, hoping for the support of the Welsh leader, Owen Glendower (see **Glendower, Owen**). In 1403, the combined armies of Henry IV and his son Prince Henry attacked Percy before he could unite with Glendower. Percy was killed, and most of his chief supporters were captured and executed. See also **Percy, Sir Henry**.

Shrewsbury and Atcham (pop. 90,900) is a local government district in Shropshire, England. It is centred on the town of Shrewsbury. Shrewsbury stands on the River Severn, 13 kilometres from the Welsh border. Its castle was begun in the 1200's. The town has many half-timbered houses, a charming square, and a fine church. See also **Shropshire**.

Shrewsbury School, founded by King Edward VI in 1552, ranks as one of England's famous public schools. It is located outside the town of Shrewsbury. After a period of decline in the 1700's, two great headmasters restored the school's reputation. Samuel Butler, who served from 1798 to 1836, raised the standards of scholarship. Benjamin Kennedy, headmaster from 1836 to 1866, added modern studies and encouraged interest in music and sports.

Shrike is a bird that can be recognized by its strong, slightly hooked beak, and by its habit of thrusting grass-

hoppers, mice, and smaller birds onto thorns, barbs, or twigs, much as a butcher hangs meat. The shrike then tears its prey to pieces and eats it. From this habit comes its common name of *butcherbird*.

There are about 70 species of shrikes. About 50 of the species are native to Africa south of the Sahara. Some African species, such as the *gonolek*, are brilliantly coloured. Many shrikes have strongly contrasting coloured plumage. For example, the *great grey shrike* of the Northern Hemisphere has grey, white, and black plumage. A dark eye stripe is a common feature of many shrikes.

Shrikes are often seen in open country perched on a telegraph wire or branch from which they can search the surrounding countryside for prey. The shrike's name may be an imitation of its harsh shriek-like call.

Scientific Classification. Shrikes belong to the family Laniidae. The gonolek is *Laniarius barbarus* and the great grey shrike is *Lanius excubitor*.

Shrimp are delicate shellfish related to crabs and lobsters. Shrimp are found in fresh and salt water in nearly all parts of the world. Some species live near the shore, where they hide in mud or sand by day and feed by night. Others swim about in groups in deep, cold water. A shrimp generally swims forward. It can swim backward by flipping its fan-shaped tail.

Most shrimp have grey, brown, white, or pink bodies. But some are red, yellow, green, or blue, and some—such as the peppermint shrimp—have stripes. Some can change colour to match their surroundings. Many species are *luminescent* (light-producing).

The smallest shrimp are less than 2.5 centimetres long. Some giant freshwater species grow over 30 centimetres long and have feelers equally long. Larger shrimp are sometimes called *prawns*.

Many small shrimp eat *plankton* (tiny drifting aquatic organisms). Large shrimp feed on material on the sea floor. Shrimp, in turn, serve as an important food for fish and other water animals. Some shrimp help "clean" fish by feeding on parasites from the gills, mouth, and scales of the fish. Other shrimp closely resemble these shrimp, but, instead of eating parasites, they take bites of the gills and flesh of the unsuspecting fish.

The body of a shrimp has two main parts, the *cephalothorax* (head and chest) and the *abdomen*. An un-



The great grey shrike preys mainly on small birds, insects, and small mammals.



Shrimp are shellfish related to crabs and lobsters. An adult shrimp of the genus *Lysmata*, above, has a bright-coloured, striped body. Some species of shrimp grow over 30 centimetres long. The smallest shrimp are less than 2.5 centimetres.

jointed shell covers the cephalothorax. A shrimp can bend because the shell of the abdomen is jointed.

Most shrimp have 19 pairs of jointed legs, feelers, and other *appendages*. The cephalothorax has two pairs of feelers, which taste the water to locate food; a pair of appendages that serve as jaws; five pairs of appendages that handle food; and five pairs of walking legs. The abdomen has five pairs of fanlike *swimmerets*, which are used in swimming and reproduction. It also has a pair of appendages that form part of the shrimp's tail.

Some kinds of shrimp have claws on their two front pairs of walking legs. A shrimp uses its claws to gather food, to fight, and to dig burrows in which to hide. The pistol shrimp makes a sound like a gunshot by snapping one of its claws.

A shrimp's shell is hard and stiff and encloses the animal's body. The only way the shrimp can grow is to *moult* (shed its shell) and grow a new shell. A shrimp moults many times during its life. A new, larger shell hardens after each moult. If any appendages have been lost, new ones develop during the course of several moults.

The life of a shrimp. Various species of shrimp have different life cycles. Some live a year at most, but others may live five years or more. Some females carry their eggs on their swimmerets until they hatch. Others lay their eggs and swim away. Some shrimp do not swim about but live in burrows in sand or mud.

The most common kinds of food shrimp, *peneid* shrimp, hatch from eggs laid up to 160 kilometres offshore. A newly hatched peneid looks like a tiny pear with legs. It changes shape several times until, after two to four weeks, it looks like a miniature adult.

Young peneid shrimp move toward shore as they develop, but 80 per cent or more may be eaten by sea animals along the way. The survivors settle in bays and river mouths. The sheltered waters of mangrove forests, rich in organic matter, are favourite nursery grounds of shrimp. After about five to seven months of rapid growth, the shrimp begin a two-month trip back to deeper water. They breed in deep water, and each female lays 500,000 to 1,000,000 eggs. Scientists believe that most of the adults die soon after the eggs are laid.

Members of another important group of shrimp, the *pandalids*, all begin life as males. At about 2 years of age, they change to females.

The shrimp industry. Fishing crews use pouch-shaped nets called *trawls* to catch shrimp. Boats drag the trawls across the bottom of the sea or river mouth. The catch is frozen or canned quickly because fresh shrimp spoil easily.

About one-third of the world's shrimp catch comes from Asia. China leads the world in shrimp production. Other countries with large shrimp catches include the United States, Thailand, and Indonesia. People in Japan sometimes rear shrimp in large tanks and ponds.

Scientific classification. Shrimp belong to the class Crustacea, order Decapoda.

See also **Fishing industry.**

Shrine is an object or place sacred to a religion. The term may also refer to a place of national or patriotic importance.

A shrine originally meant a box or chest that contained holy objects. It later came to mean the place

where such a container is kept. A shrine is also any structure built on a place considered holy because some significant religious event happened there. In addition, shrines may be built to honour a saint or a virtue. National shrines, such as the Washington monument in the United States, or the Tomb of the Unknown Soldier, honour the memory of national heroes. Many people travel to religious and national shrines to honour whom-ever or whatever the shrine memorializes.

See also **Fátima; Kaaba; Lourdes; Sculpture (Oriental); Unknown Soldier.**

Shropshire (pop. 401,600) is an English county in the western Midlands, on the border with Wales. It is mainly a farming county. But Shropshire was one of the first areas to develop engineering during the Industrial Revolution in the 1700s. Since then, engineering has always been an important industry in Shropshire.

Shropshire has much beautiful countryside. Visitors can also see several ancient castles, built to keep out invaders from Wales. The county was the scene of fierce border fighting between English and Welsh forces for many hundreds of years.

People and government

Recreation and sport. Shropshire provides good opportunities for a wide range of sports. Many people enjoy fishing or boating on the River Severn. Competitive boating regattas are held every year at Bridgnorth, Ironbridge, and Shrewsbury. Boating is popular near Ellesmere. Telford has an ice rink and a tennis centre.

The Midland Gliding Club has its headquarters near Church Stretton. Motor clubs organize hill climbing or motorcycle scrambling at Hawkstone near Wem, and at Loton, near Alberbury. At Lilleshall, the Lilleshall National Sports Centre provides residential courses for a wide variety of organized sports. The sports centre is run by the Sports Council.

Cultural events in Shropshire include annual festivals at Ludlow and Bridgnorth. Both festivals specialize in plays by William Shakespeare.



Shropshire, an English county in the western Midlands, lies on the border with Wales. It is a largely farming county.



The Teme Valley in south-western Shropshire yields some crops, but farmers traditionally have reared mainly cattle and sheep.

Local government. Shropshire is divided into six local government districts: *Bridgnorth*; *North Shropshire*, which includes the towns of Market Drayton, Wem, and Whitchurch; *Oswestry*; *Shrewsbury and Atcham*; *South Shropshire*, which includes Bishop's Castle, Church Stretton and Ludlow; and *The Wrekin*. The new town of Telford, which includes Dawley, Oakengates, and Wellington, is in The Wrekin.

Shropshire is policed by the West Mercia Constabulary. The crown court meets at Shrewsbury.

Economy

Agriculture is the most important part of Shropshire's economy. Half of the farms are less than 12 hectares in size. Farmers in the fertile eastern lowlands grow mainly barley, potatoes, sugar beet and wheat.

Dairy farmers work in the northern and western regions of the county, where clay soils provide rich pasture land. Farmers keep mainly Friesian or Ayrshire cattle. Some farmers also breed pigs, feeding them partly on cow's milk.

Farmers in southwestern Shropshire graze beef cattle, mainly Herefords, on the area's hilly land. Some also cultivate barley, oats, wheat, and green crops, mainly for cattle food. Farmers in the hills rear sheep.

Manufacturing. Industries in Shropshire include electronics, light engineering, plastics, and the production of clothing, concrete, and iron and steel goods. The Telford new town area has a wide range of industries. Its products include bricks, concrete and earthenware pipes, industrial robots, iron and steel, photocopiers, televisions, and video tapes.

Bridgnorth has factories producing aluminium foil, electrical parts, and precast concrete. The market town of Oswestry has developed new industries in recent years. Its manufactures include aluminium kitchenware, engineering goods, plastics, and processed foods.

Transportation and communication. Shrewsbury is the centre of the county's rail system. A main line links Shrewsbury with Birmingham, by way of Telford and Wolverhampton. Other lines link Shrewsbury with Chester, by way of Wrexham, and with Manchester, western Wales, Cardiff, and South Wales.

The county's road system also converges on Shrewsbury. The M54 links Shrewsbury and Telford to the national motorway system.

Shropshire has only one daily newspaper, the *Shropshire Star*, which is published in Telford. Weekly newspapers are published for many towns. A BBC local radio station, Radio Shropshire, operates from Shrewsbury.

Land

Location and size. Shropshire is bordered by Cheshire on the north, Staffordshire on the east, Hereford and Worcester on the south, and Clwyd and Powys on the west. The county extends about 65 kilometres from east to west and about 80 kilometres from north to south.

Land features. About three-fifths of Shropshire is lowlands. Uplands cover the mid-south, southwest, and northwest of the county. The River Severn divides the two regions. Ancient rocks form the hills, including the Clee Hills, Wenlock Edge, and Long Mynd, which is 517 metres high. The hills become moorland near the Welsh border. The Clun Forest runs along part of the border. The lowlands in the northeastern half of Shropshire average 60 metres above sea level. The Wrekin, an isolated hill rising 407 metres, stands near Telford. This hill is of volcanic origin.

The Severn is the main river of Shropshire. The River Teme flows along part of Shropshire's southern boundary and joins the Severn just south of Worcester.

Climate. Rainfall in Shropshire averages between 600 and 750 millimetres a year. Temperatures in the region average 4° C in January and 16° C in July.

History

The present-day village of Wroxeter, near Shrewsbury, occupies the site of the ancient Roman city of *Viroconium*. The Roman city stood at the junction of several Roman roads, including Watling Street. The Ro-

Facts in brief about Shropshire

Administrative centre: Shrewsbury.

Largest towns: Telford, Shrewsbury.

Area: 3,490 km².

Population: 1991 census—401,600.

Chief products: *Agriculture*—barley, beef cattle, dairy products, pigs, potatoes, sheep, sugar beet, wheat.

Manufacturing—aluminium goods, concrete, diesel engines, electrical goods, iron and steel goods, office automotive equipment, and plastics.



Lilleshall Abbey is one of the many historic remains in Shropshire. Today, it lies in ruins. Nearby is the Lilleshall National Sports Centre, which provides residential sports courses.

mans developed Viroconium as an industrial centre and it finally became the fourth city of Roman Britain. Some relics of the city remain on the site of the town.

Shropshire became part of the Kingdom of Mercia in the 700's. Offa, the greatest of the kings of Mercia, planned the earthwork, which is now called Offa's Dyke, to mark the western border of the Kingdom of Mercia with Wales. Edward I started campaigns against the Welsh in 1276. In 1282, Edward's forces surrounded the Welsh prince Llewelyn and his people and starved them into surrender. Shrewsbury was an important base for the wars in northern Wales.

In about 1709, Abraham Darby succeeded in smelting iron ore with coke at Coalbrookdale, near Ironbridge. Before he discovered this method, industrial progress had been held up because of the shortage of charcoal, which was used in furnaces. Coke forges sprang up in all parts of the area, using locally mined coal.

Shropshire became famous for crafts such as firing encaustic tiles, pottery, and ironworking. The first iron rails were cast at Coalbrookdale. China made in Coalport was once famous throughout the world. Shropshire people made clogs for the workers in the Lancashire

cotton mills. But many of these old crafts have died out.

Famous people connected with Shropshire include Robert Clive, the soldier and administrator in India, who was born in the county in 1725, and the naturalist Charles Darwin, who was born in Shrewsbury in 1809. The poet A. E. Housman is associated with Shropshire because of his book of poems, *A Shropshire Lad* (1896).

Shroud of Turin is a linen cloth that many people believe was the burial cloth of Jesus Christ. The cloth measures 434 by 109 centimetres. It bears a faint image of the front and back of a man who was whipped, crowned with thorns, and crucified. Wounds on the image follow the details of the death of Jesus as described in the Bible. The shroud is kept in a chapel of the cathedral in Turin, Italy.

Places to visit

Following are brief descriptions of some of Shropshire's interesting places to visit:

Ellesmere is a centre for fishing and for boating on the *meres* (small lakes) that surround the town.

Ironbridge Gorge Museum is a collection of industrial archaeology sites and monuments spread over 16 square kilometres (6 square miles) of the Severn Gorge. It includes the world's first iron bridge. The main site at Blist's Hill contains a Victorian town and many working and static exhibits.

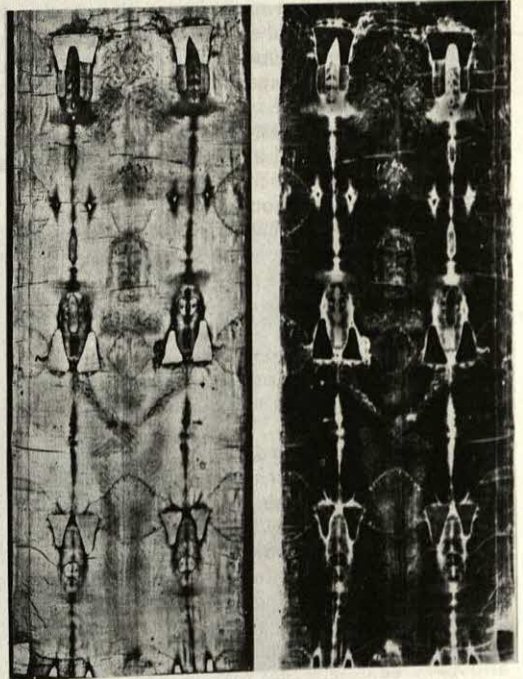
Ludlow is a tourist centre with a number of beautiful historic buildings. The castle is the setting for an annual festival of drama, music, and the arts.

Offa's Dyke can be seen in many parts of western Shropshire, especially at Clun. The dyke was built by Offa, King of Mercia, in the A.D. 700's, to mark the western boundary of his kingdom.

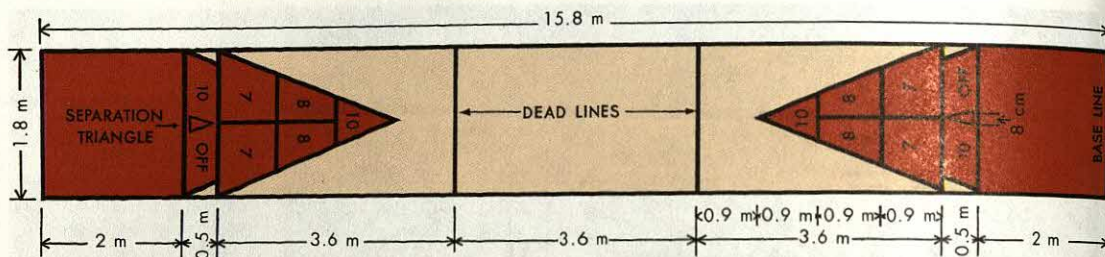
Stokesay Castle, near Craven Arms, is a fortified manor house built in the 1200's. The castle is extremely well preserved and is open to the public.

Wenlock Edge is a limestone ridge about 25 kilometres long. It provides wonderful views over central Shropshire.

The Wrekin is a strange, isolated hill near Telford. From the top, more than 10 counties of England and Wales can be seen.



A photograph of the Shroud of Turin shows positive and negative images of a crucified man. Many people believe that the shroud was the burial cloth of Jesus Christ.



Shuffleboard can be placed on a smooth, narrow surface, such as a ship's deck.

Some people believe the shroud is actually the *Mandylion*, a cloth that first appeared in Edessa (now Urfa, Turkey), in the 500's. The Shroud of Turin closely resembles artists' copies of the Mandylion from this period. The Mandylion was taken to Constantinople (now Istanbul, Turkey), in 944. The Mandylion disappeared in 1204, during the Fourth Crusade.

About 1355, the Shroud of Turin was in the possession of Geoffrey de Charny, a French nobleman. In 1453, the House of Savoy, a royal family of Italy, acquired the cloth. The Savoyes took it to Chambéry, France, where it was damaged in a fire in 1532. They took the shroud to Turin in 1578.

Many people have challenged the authenticity of the shroud. In 1389, the bishop of Troyes, France, condemned the shroud as a forgery painted in about 1355. In 1898, the first photographs of the shroud cast doubt on this theory. The negatives of the photographs showed a positive image much clearer and more detailed than the image on the shroud. Thus, it appears that the shroud is a negative image. According to experts, no medieval artist could have painted such an image.

During the 1970's and 1980's, scientists performed many tests on the shroud. In 1978, a team of researchers found that bloodstains on the cloth appeared to be human blood. The team concluded that the image was probably produced by a human body. Other scientists found that pollens and limestone dust from the cloth could have come from the region of Palestine where Jesus died. But the tests proved nothing conclusive. In 1988, scientists used a test called *radiocarbon dating* on cloth from the shroud to determine its age. The tests indicated that the shroud dates only to about 1350. However, some historians and scientists have challenged this conclusion.

Shrove Tuesday is the day before Ash Wednesday, the beginning of Lent. Its name comes from the custom of making confession of sin and receiving forgiveness (being *shriven*) on that day. Shrove Tuesday is a time of celebration in many countries. It corresponds with *Fastnacht* in Germany and *Mardi Gras* in France and the Southern United States. The English celebrate Shrove Tuesday as *Pancake Tuesday* or *Pancake Day*. They traditionally cook and eat flat, thin pancakes on that day. See also **Ash Wednesday**; **Lent**; **Mardi Gras**.

Shrub is one of the four main groups of plants in terms of size and form. A shrub is a perennial with woody stems that is smaller than a tree. Shrubs usually have

several low stems branched near the ground. Bushes have many branches (see **Bush**). Trees have one large stem, the trunk. Shrubs differ from vines because they stand up without support and do not climb. They differ from herbs because they have hard, woody, long-lived stems. Shrubs grow in almost all parts of the world. They provide cover and food for birds and game, and they protect the soil from erosion. Shrubs are popular for planting along foundations of houses, in gardens, and as hedges around lawns. Many shrubs produce fragrant blossoms or decorative leaves, twigs, and fruits.

Most shrubs will grow in well-drained soil, dug to a depth of from 45 to 60 centimetres. Smaller plants may be spaced 60 to 90 centimetres apart, the larger ones 1.5 metres apart. Transplanting may be done in the autumn or spring. For best growth, prune old branches.

For a list of *World Book* articles on shrubs, see the *Related articles* at the end of the **Plant** article.

Shuard, Amy (1924-1975), was one of the finest English dramatic sopranos. The dramatic intensity of her acting and her strong, agile voice combined to bring her fame as an opera star. Her dramatic strength was seen at its best in *Turandot* by Puccini. She sang the principal role in this opera at the Royal Opera House, Covent Garden, in 1958. Amy Shuard was born in London, and studied at Trinity College of Music.

Shuffleboard is a game played on a flat, smooth, surface. The players use long-handled sticks called *cues* to try to push plastic discs into a scoring area at the other end of the shuffleboard court. A player also tries to knock his or her opponent's discs out of the scoring area or into a penalty space.

A shuffleboard court is 15.8 metres long. A disc may measure no more than 6 inches (15.24 centimetres) in diameter. The cue may be no longer than 191 centimetres. Most cues have a head shaped like a half moon. A disc fits into the curved space.

Shuffleboard can be played by two people or by two teams of two players each. The opposing players stand behind the 10-off space of the court and take turns shooting discs until each person has shot four. A player scores 10 points for each disc in the 10 area, 8 points for the 8 area, and 7 points for the 7 area. He or she loses 10 points as a penalty for each disc in the 10-off space. The winning score may be 50, 75, or 100 points.

Shultz, George Pratt (1920-), served as secretary of state in the administration of President Ronald Reagan from 1982 to 1989. He had previously held several important positions under President Richard M.

Nixon. Shultz also served in the United States and abroad as an adviser to governments and to management and labour groups. As an arbitrator in labour disputes, he became noted for his fairness and his ability to bring about settlements.

Before joining the Reagan Administration, Shultz served seven years as president of the Bechtel Group, Inc., a large international engineering company. From 1972 to 1974, he was secretary of the treasury and chairman of the Council on Economic Policy in the Nixon Administration. During that period, he was responsible for coordinating decisions affecting the government's economic policy. Shultz served as director of the Office of Management and Budget from 1970 to 1972.

Shultz was born in New York City. He graduated from Princeton University in 1942 and received a Ph.D. degree from the Massachusetts Institute of Technology (M.I.T.) in 1949. Shultz taught economics at M.I.T. from 1948 to 1955, and in 1956 and 1957. He became a professor of industrial relations at the University of Chicago in 1957 and dean of the graduate school of business in 1962.

Shush. See *Susa*.

Shute, Nevil (1899-1960), was a British writer of best-selling novels of tension and adventure. He published his first novel, *Marazan*, in 1926. The best known of his more than 20 novels included *No Highway* (1948), *A Town Like Alice* (1949), and *On the Beach* (1953). Shute was born at Ealing, in London. His full name was Nevil Shute Norway. He graduated from Oxford University after serving as a pilot during World War I. He had a successful career as a designer and builder of aircraft. His special knowledge gives many of his novels great authenticity. During World War II, he served in a section of the Navy devoted to designing weapons. After the war, he settled in Australia.

Shuttle. See *Weaving* (Weaving on a loom).

Shyness. See *Child* (Other special problems); *Introvert*.

Si Kiang. See *Xi Jiang*.

Siam. See *Thailand*.

Siamese cat. See *Cat* (Short-haired; picture).

Siamese fightingfish. See *Fightingfish*.

Siamese twins, also called *conjoined twins*, are twins joined at some point of their bodies. Such twins most commonly are joined at the hip, chest, abdomen, buttocks, or head. Some also share an internal organ, such as a heart or a liver. Siamese twins are *identical twins*—that is, they have identical genetic makeups. Siamese twins occur about once in every 50,000 births. Only about 500 cases have been reported worldwide, but many more have probably occurred.

Siamese twins are believed to originate from a single, fertilized egg whose cell mass has failed to divide completely. If the cell mass divides fully, separate identical twins are formed. Doctors do not know why the division is incomplete in Siamese twins.



Nevil Shute

Doctors can determine if a pregnant woman is carrying Siamese twins by means of X rays, *ultrasound* (high frequency sound waves), and other techniques of diagnosis. In some cases, normal delivery through the mother's vagina is possible. In most cases, however, the doctor performs a *Caesarean section* (incision into the womb) to deliver Siamese twins.

Surgery to separate Siamese twins is a complex task. Each case must be evaluated before the operation by a team of medical specialists. Often, the surgery results in the death of one or both of the twins.

The term *Siamese twins* originated from Eng and Chang, a set of conjoined twins from Siam (now Thailand) who appeared in travelling exhibitions and became internationally famous in the 1800's.

See also **Multiple birth**.

Sibelius, Jean (1865-1957), was a Finnish composer. His most important works are his seven symphonies and many symphonic poems for orchestra. Sibelius based most of his symphonic poems on Finland's national epic poem, the *Kalevala*. These compositions express Sibelius' impressions of Finland's forests, lakes, cool summers, and snowy winters.

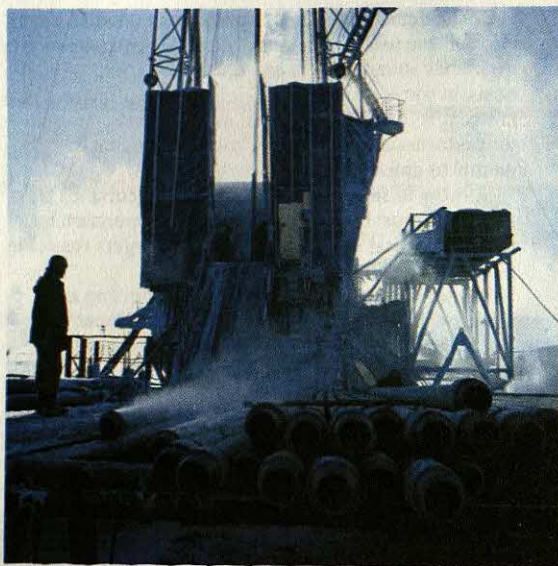
Sibelius' earlier and more melodious compositions became his most popular works. They include *The Swan of Tuonela* (1893), *Finlandia* (1900), *Second Symphony* (1902), and *Valse Triste* (1903). Sibelius developed a less melodious style after about 1904. His *Fifth Symphony* (1915) is the best introduction to his later style. In both his earlier and later symphonies, Sibelius first stated his themes in fragmentary form. He developed the themes during the composi-



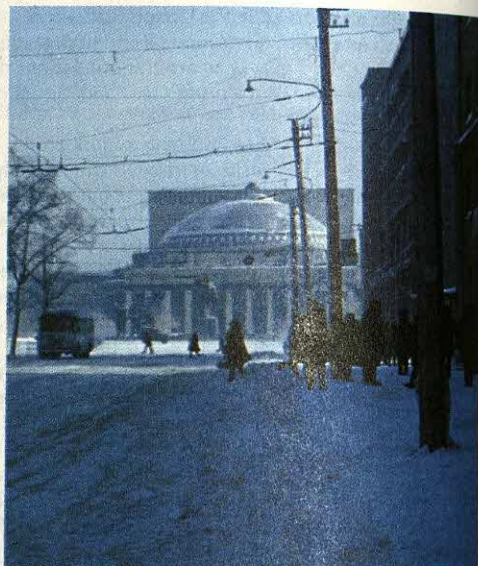
Jean Sibelius



Chang and Eng were famous Siamese twins joined at the ribcage. The term *Siamese twins* originated with them. The brothers were born in Siam (now Thailand) in 1811 and died in 1874.



Drillers sink an oil well into the frozen ground at Samotlor, a Siberian oil field near the Ob River, about 720 kilometres northwest of Novosibirsk. Wells along the Ob River produce most of Russia's oil. The field is being developed further.



Novosibirsk is Siberia's biggest city and one of the largest in Russia. The city was founded in 1893 and expanded rapidly after the government established many factories there during World War II (1939-1945).

tion and presented them in complete form near the end of the work.

Jean Julius Christian Sibelius was born in Hämeenlinna, southwestern Finland, the son of a doctor. He studied music at the Helsinki Conservatory and then, from 1889 to 1892, in Berlin and Vienna. The government awarded Sibelius a pension in 1897, enabling him to devote himself to composing. His most famous work, *Finlandia*, was first performed in 1900 in Helsinki. At that time, Russia ruled Finland. *Finlandia* expressed so much national pride and patriotism that the Russians refused to permit its performance. But the work became the anthem of the Finnish independence movement. Russian troops left Finland in 1918.

During the early 1900's, Sibelius became internationally known as a composer and conductor. But he stopped composing in 1929 because he did not wish to write in the modern styles.

Siberia is a vast, thinly populated region in northern Asia. It lies within Russia. Siberia makes up about 75 per cent of the area of Russia but only about 20 per cent of the Russian people live there. Ice and snow cover most of the region for about six months a year, and the temperature sometimes drops below -68°C .

The Soviet Union was formed under Russia's leadership in 1922, and it existed until 1991. Through the centuries, Russian and, later, Soviet rulers sent millions of criminal and political prisoners to isolated parts of Siberia. Many prisoners were forced to work as labourers building factories, mines, and railways. Since the 1930's, Siberian mines have been a rich source of coal, oil, natural gas, and minerals.

Land and climate

Siberia covers about 10,968,600 square kilometres. It has three main areas—the West Siberian Plain, the Cen-

tral Siberian Plateau, and the East Siberian Highlands. The West Siberian Plain, a flat area of swampy forests, extends from the Ural Mountains to the Yenisey River. The Central Siberian Plateau lies between the Yenisey and Lena rivers. Lake Baikal, the world's deepest lake, lies on the plateau's southern edge. Lake Baikal is 1,620 metres deep. The East Siberian Highlands are a series of mountain ranges lying between the Lena River and the Pacific coast. This area includes Siberia's highest point, the active volcano Klyuchevskaya, which rises to 4,750 metres.

Moss, lichens, and a few kinds of small shrubs grow in the *tundra*, a narrow belt of vegetation along Siberia's Arctic coast. South of the tundra, a vast evergreen forest called the *taiga* spreads from the Urals to the Pacific coast. In the extreme southwest lie the *steppes* (grasslands), Siberia's richest farming area.



Location of Siberia

Arctic foxes, lemmings, and reindeer live in the tundra; and lynxes, red foxes, sables, and stoats make their home in the taiga. Fishing crews catch cod, crabs, and salmon off the Pacific coast.

Average temperatures in northeastern Siberia range from -51°C in January to 15°C in July. In the steppes, they vary from -16°C in January to about 18°C in July. The annual *precipitation* (rain, melted snow, and other moisture) averages 13 centimetres in the north and 80 centimetres in the steppes. A layer of permanently frozen ground called *permafrost* covers most of eastern Siberia.

People

Siberia has a population of 31 million, but the region has a population density of only 2 people per square kilometre. The European part of Russia is more than 12 times as densely populated as Siberia. Siberia's population has grown slowly. During some years, because of the harsh living conditions, more people leave Siberia than move there.

The use of forced labour for Siberian construction projects ended after the Soviet dictator Joseph Stalin died in 1953. The government then began trying to attract workers to Siberia by offering such rewards as high salaries and long holidays. But many workers stay only a few years before leaving for better living conditions elsewhere.

Most people living in Siberia are Russians. The government has moved many settlers into the region since the 1700's. Such Mongol and Turkic groups as Buryats, Tuvians, and Yakuts lived there originally.

About 70 per cent of Siberia's people live in cities. The rest live in rural areas. Most city people are crowded into small flats. Many people in rural areas live in simple, but more spacious, log houses. Siberia's largest city is Novosibirsk. Other large cities include Chelyabinsk, Krasnoyarsk, Omsk, and Sverdlovsk.

Economy

Siberia has an abundance of natural resources. Many minerals, including diamonds, gold, platinum, tin, and tungsten, are mined in harsh, isolated areas. Vast oil fields along the Ob River began operating in 1965. The fields now produce most of Russia's oil. Much of the country's coal comes chiefly from deposits in the Kuznetsk Basin. Natural gas reserves near the Arctic coast in western Siberia supply most of Russia's gas. There are also gas reserves around Yakutsk in the east of the region. Siberian forests produce most of Russia's timber.

Over half of Russia's electric power comes from hydroelectric dams on Siberia's rivers. Sayano-Shushensk Dam on the Yenisey River, one of the world's largest power dams, generates about $6\frac{1}{2}$ million kilowatts.

Siberian manufacturing is centred mainly in the Kuznetsk Basin. Leading products include building materials, chemicals, and farm machinery. The southern steppes include the region's most productive farmlands. Farmers there grow barley, oats, and wheat. Livestock reared in Siberia include cattle, sheep, and reindeer, and the region has many dairy farms.

The Trans-Siberian Railway, which crosses southern Siberia, carries passengers and freight to and from the European part of Russia. Almost all of Siberia's re-

sources are used in the European part, where most of the people live. The railway transports coal and other minerals, and pipelines carry oil and natural gas to Russia and other European countries. The major rivers of Siberia flow into the ice-bound Arctic Ocean, where ice-breakers keep shipping lanes open for only a few months in summer. Airlines connect Siberian cities with cities in the European part of the country.

A network of radio stations and a television communications satellite serve all Siberia. Telegraph lines connect the major areas of the region.

History

People were living in Siberia by about 30,000 years ago. Asian nomads called Tatars, under the Mongolian emperor Genghis Khan, conquered the southern steppes during the early 1200's (see Tatars). They drove many of the original tribes into the northern forests. In the late 1500's, a band of Russian Cossacks, led by an adventurer named Yermak, defeated the Tatars. Russian fur traders reached the Pacific coast about 1630. By 1700, the Russians controlled almost all Siberia.

In the early 1900's, the national government began to build industries in Siberia. It moved hundreds of factories and thousands of workers from the European part of the Soviet Union to Siberia during World War II (1939-1945). This action protected the factories from destruction by the German armies that invaded the Soviet Union from the west.

In the mid-1900's, scientists discovered large deposits of coal, oil, and other minerals in Siberia. Oil and natural gas production on a large scale began in the 1960's and 1970's. The Soviet Union and Japan signed an agreement in 1974 to develop a coal mine in eastern Siberia for the Japanese steel industry. That same year, construction began on a 3,100-kilometre railway called the Baikal-Amur Mainline, which was to run between Lake Baikal and Komsomolsk, about 320 kilometres north of Khabarovsk. The railway opened in 1984, but construction was expected to continue throughout the late 1900's. This has encouraged development in eastern Siberia.

Related articles in *World Book* include:

Cities

Irkutsk	Sverdlovsk
Novosibirsk	Vladivostok
Omsk	

Physical features

Amur River	Sakhalin
Kamchatka Peninsula	Ural Mountains
Lake Baikal	Yablonovy Mountains
Lena River	Yenisey River
Ob River	

Other related articles

Arctic	Russia	Union of Soviet
Inuit	Trans-Siberian	Socialist
Permafrost	Railway	Republics

Siberian husky is an Arctic sledge dog. It is related to the Alaskan malamute, the Eskimo dog, and the Samoyed. It originated in Siberia. A graceful, quick dog, the husky is also alert and strong. It has a thick, soft, double coat, with a smooth outer coat and a downy undercoat. The commonest colours of Siberian huskies are grey, tan, or black, often with white markings. The husky



The Siberian husky is an alert, powerful dog.

stands about 50 to 60 centimetres high, and weighs 16 to 27 kilograms. See also **Dog**.

Sibyl was the name ancient Romans gave to any aged woman who could supposedly foretell the future. The best known was the Cumaean Sibyl. According to mythology, the god Apollo promised that she would live one year for each grain of sand she could hold in her hands. But Apollo did not give her eternal youth, and she continued to age. Sibyl guided Aeneas, the Trojan warrior, to the lower world to learn the future of Rome. Later, she offered to sell nine books of prophecy, called the Sibylline Books, for a high price to a king of Rome. When the king refused twice, Sibyl burned three books each time. The king finally paid the original price for only three. These books were consulted in times of danger until they were destroyed by fire in 83 B.C.

Sicilies, Kingdom of the Two, was the name of an early kingdom of Italy. It consisted of the Kingdom of Naples in southern Italy, and the Kingdom of Sicily on the island of Sicily. At times, they were united as the *Two Sicilies* (see **Italy** [maps: Italy about 1200; the Unification of Italy]). The kingdom was formed in the early 1100's by Normans, who conquered the region in the 1000's.

In 1266, the Two Sicilies came under French rule. In 1282, an uprising known as the Sicilian Vespers took place in Sicily. It resulted in the massacre of nearly all the French on the island. Sicily was later separated from Naples and ruled by the Spanish. In the War of the Spanish Succession in 1713, Austria seized Naples, and Sicily was given to Savoy. Savoy turned Sicily over to Austria in 1719, in exchange for Sardinia.

In 1734, Spain conquered the Two Sicilies, and the Spanish Bourbon family ruled them until the time of Napoleon. King Ferdinand I joined the allies against France and lost Naples as a result. The two parts of the kingdom were reunited after Napoleon's downfall.

The Kingdom of the Two Sicilies played an important part in the movement for a united Italy. In 1820, there was an uprising in Naples of the Carbonari, a secret nationalist society. King Ferdinand was forced to grant the Neapolitans a constitution. An Austrian army invaded Naples, and restored Ferdinand to power.

In 1860, the Italian military leader Giuseppe Garibaldi

conquered the Kingdom of the Two Sicilies for the Kingdom of Italy, which was just coming into being. Later, the Kingdom of the Two Sicilies became part of the domain of Victor Emmanuel, king of Italy from 1861.

Sicily (pop. 4,863,587) is an Italian island in the central Mediterranean Sea. The Strait of Messina separates Sicily from the mainland of Italy. For Sicily's location, see **Italy** (political map). Sicily covers an area of 25,708 square kilometres and is the largest island in the Mediterranean.

Sicily is one of Italy's 20 governmental *regions*. Palermo, a centre of industry and trade, is the capital, largest city, and chief seaport of Sicily. Workers commute daily by ferry across the strait between Messina, on the northeastern coast, and the Italian mainland.

People. Sicily's location long made it a crossroads for many civilizations. A number of peoples colonized the island, including Greeks, Carthaginians, Romans, Normans, and Muslims from North Africa. Today, Sicily has a mixture of these civilizations. For example, the people speak local *dialects* (forms of speech) that have traces of Arabic, Greek, and other languages.

The people of Sicily have strong bonds of family and friendship. The hundreds of years of invasion and foreign rule discouraged the people's trust in government and encouraged a code of *omertà*. According to the code, a person who cooperates with the government is dishonourable. This code and the island's tradition of private justice provide support for the Mafia. The Mafia is a network of groups engaging in illegal activities that range from animal rustling to drug dealing. Protection for Mafia activities also has come from politicians who owe their positions to Mafia support. However, many Sicilian people are becoming increasingly opposed to Mafia activities. During the 1980's, the Italian government convicted hundreds of people associated with the Mafia. See **Mafia**.

Many Sicilians are farmers. Others work in the fishing industry and other industries. A lack of jobs was a chief reason for a high rate of emigration in the late 1800's and early 1900's. From 1876 to 1925, more than a million Sicilians moved to the United States. Since 1945, large numbers of Sicilian workers have settled in the industrial cities of northern Italy, France, Germany, and Switzerland.

Most of Sicily's people are Roman Catholics. Their religious celebrations often include colourful processions, horse races, pole-climbing contests and elaborate firework displays.

Many famous landmarks attract tourists to Sicily. Greek ruins stand at Agrigento, Syracuse, Taormina, and other places in Sicily. Many Sicilian cathedrals and palaces exhibit works of art. Educational institutions include universities in Catania, Messina, and Palermo.

Land and climate. Mountains and hills cover more than 85 per cent of Sicily. Its highest point is Mount Etna, an active volcano that rises to 3,390 metres on the island's east coast. Mount Etna erupts periodically. One such eruption destroyed Catania in 1669, and it had to be rebuilt. But the area is heavily populated because volcanic ash makes the soil fertile. Etna again erupted in 1990. Earthquakes also hit Sicily. Messina had to be rebuilt after an earthquake destroyed it in 1908.

Sicily has a mild climate. Temperatures average 7° C

in winter and 26° C in summer. The island gets most of its rain during the winter. Little rain falls from March to October, and the air becomes even drier because of a hot, dry wind called the *sirocco*. This wind blows across the Mediterranean Sea from the deserts of North Africa. Sicilian rivers dry up in summer, and the land becomes parched in unirrigated areas.

Sicily was once heavily wooded, but most of the trees have been cut, leaving the mountainsides bare and easily eroded. Farmers use much of the island for growing cereals and for grazing goats and sheep. Along the coasts, irrigation provides water for such crops as almonds, grapes, lemons, olives, oranges, and potatoes.

Economy. Sicily has prospered many times in its long history. But since the 1400's, its economy has become underdeveloped. Most of the land was divided into large estates owned by a few people. Farmers used outdated methods and made little effort to prevent soil erosion. Sicily had few industries to provide jobs. In the 1800's, Sicilian sulphur mines supplied four-fifths of the world's sulphur. By 1900, however, foreign competition had weakened the industry.

Since the 1950's, Sicily's economy has started to improve. A government land reform programme broke up some of the large estates, and small farmers received plots of their own. The government planted trees to prevent erosion, expanded irrigation projects, and built dams to collect winter rainfall for use in the summer.

Several industries developed in Sicily during the 1900's. Part of this development resulted from the discovery of oil at Ragusa in 1954 and later at Gela. A pipeline opened in 1957 and linked the Ragusa oil field to a large refinery in the port city of Augusta. Factories in several coastal cities refine sulphur and make fertilizer from potash. Sicily produces asphalt and salt. Sardine and tuna fishing also are important.

Government. In 1948, Sicily became a semi-independent political region of Italy. The island has nine provinces and a 90-member parliament. It also sends representatives to the federal government in Rome.

History. Discoveries of cave drawings and tools show that prehistoric people lived in what is now Sicily. During the 700's B.C., the Greeks colonized the eastern part of the island, and the Carthaginians founded trade settlements in the western part. The Romans conquered Sicily in the 200's B.C. and made it their first province. Sicily grew grain for the Roman Empire.

After Rome declined during the A.D. 400's, the Vandals and the Ostrogoths conquered Sicily. In 535, the island came under the control of the Byzantine Empire. North African Muslims replaced the Byzantine rulers in the 800's. Sicily flourished during about 200 years of Muslim rule. The Muslims introduced irrigation and such crops as cotton, lemons, and oranges. Muslim art, literature, and science influenced the Sicilians.

During the 1000's, the Normans conquered Sicily. They joined Sicily with southern Italy and formed the Kingdom of the Two Sicilies. Under the Normans, the island's culture gradually became Western European. In the 1200's, German—and, later, French—rule added to the mixture of traditions in Sicily. During this period, Sicily became the cultural centre of Italy. In 1282, an uprising called the *Sicilian Vespers* ended French rule.

During the next 400 years, Sicily was ruled by Spain, Savoy, and Austria. In the 1700's, Sicily became part of the Bourbon Kingdom of the Two Sicilies. After the Italian patriot Giuseppe Garibaldi invaded Sicily in 1860, the island revolted against Bourbon rule. Sicily then became part of the Kingdom of Italy.

During World War II, Allied troops landed on Sicily on July 10, 1943. The Allies occupied all of Sicily after Messina fell on August 17. The island then became the springboard for the Allied invasion of Italy.

In the 1950's, Sicily began a road construction programme. Sicily's first motorway, linking Catania and Messina, opened in 1971.

Related articles in *World Book* include:

Garibaldi, Giuseppe
Italy
Messina

Palermo
Sicilies, Kingdom of the Two
Syracuse



The town of Taormina, Sicily, lies among the hills near Mount Etna, a snow-capped volcano, background. Hills and mountains cover most of Sicily, and Mount Etna is its highest peak.

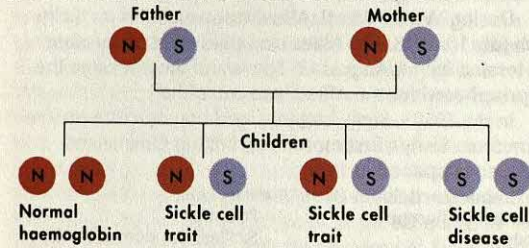
Sickert, Walter Richard (1860-1942), was a German-born artist whose technical brilliance and bold style had a great influence on painting in the United Kingdom. He was a leading member of the New English Art Club, but later broke away from it to found the Camden Town Group. Sickert was born in Munich and studied at the Slade School, in London, under James Whistler. He was elected to the Royal Academy in 1934. See also **Whistler, James Abbott McNeill**.

Sickle cell disease is a hereditary blood disease that occurs chiefly among black people. It also affects other groups, including people of Middle Eastern and Mediterranean origin. Sickle cell causes periodic attacks that include severe pain and fever and can damage body organs. It may injure almost all parts of the body, especially the bones, the liver, the lungs, and the spleen. Such injuries can lead to strokes, kidney failure, severe infections, and sudden death. Many deaths occur in childhood as a result of infection or stroke. However, most people with the disease live 50 years or more.

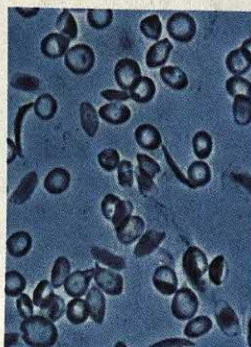
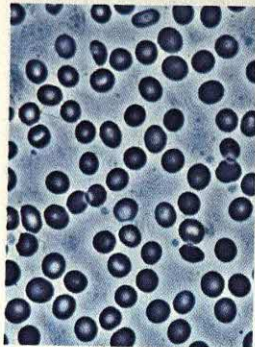
Sickle cell disease, also known as *sickle cell anaemia*, occurs when a person's red blood cells lack normal *haemoglobin*. Haemoglobin is the substance that makes

Sickle cell disease

Sickle cell disease is a hereditary blood condition that can damage body organs. People who suffer from it have inherited the gene for sickle haemoglobin from both of their parents.



In the chart above, each parent carries genes for normal and sickle haemoglobin. A child of such parents has one chance in four of inheriting the gene for sickle haemoglobin from both parents, and thus developing sickle cell disease. People who inherit the gene for sickle haemoglobin from one parent do not get sickle cell disease. But they have a condition called *sickle cell trait* and can pass the sickle gene on to their children. The magnified blood samples below show normal red blood cells, *left*, and abnormal blood cells of a person with sickle cell disease, *right*. Typical blood cells that have sickle haemoglobin are long, pointed, and deep red. The other cells have sickle haemoglobin but have not yet changed into twisted sickle forms.



blood red and carries oxygen from the lungs to the body tissues. The blood of people with sickle cell disease contains an abnormal type of haemoglobin called *sickle haemoglobin* or *haemoglobin S*. Sickle haemoglobin forms a type of crystal in the red blood cell when the cell loses oxygen as it goes through tiny blood vessels, called *capillaries*, into the veins. The crystal causes the normally round red blood cells to change into slender, twisted, rigid sickle forms.

Sickled cells can get trapped in capillaries and thus block the normal flow of blood through them. If these vessels are clogged, oxygen cannot get to the tissues. This condition causes the periodic attacks.

Sickle cell disease occurs when a child inherits the gene for sickle haemoglobin from both parents. Scientists have determined that the gene is located on *chromosome 11*, one of the 23 pairs of chromosomes in human cells. Patients are given medicine to relieve pain and to treat any infections.

See also **Races, Human** (Susceptibility to genetic diseases); **Cell** (Metabolic diseases).

Sickness. See **Disease**.

Siddhartha Gautama. See **Buddha**.

Siddons, Sarah Kemble (1755-1831), was one of England's greatest tragic actresses. She enchanted audiences and critics with her rich voice, striking beauty, and powerful presence. She became a subject of poets and painters.

Siddons was the daughter of Roger Kemble, an English actor. She was born in Wales, where her father was touring with his acting company. She married actor William Siddons when she was 18. During the 1775-1776 season, Siddons failed as an actress in David Garrick's Drury Lane Theatre in London. She gained more experience acting in the English provinces, rejoined Garrick's company in 1782, and became a success. Her brothers Charles Kemble, John Philip Kemble, and Stephen Kemble also became celebrated actors.



Portrait by Thomas Gainsborough, The National Gallery, London

Sarah Siddons

See also **Shakespeare, William** (The Age of Garrick; picture); **Garrick, David**.

Sidereal time measures the rotation of the earth in relation to the stars. *Solar time*, which we use to tell time, measures the earth's rotation in relation to the sun. Astronomers use sidereal time because the same stars are always in the same place the same sidereal time from day to day. The same stars do not appear in the same place the same solar time each night.

A sidereal day consists of 24 sidereal hours. It is the time the earth takes to rotate once on its axis past an imaginary line from the earth's centre to any star. Astronomers measure sidereal time from a point in the sky called the *vernal equinox*. But no bright star marks this point (see **Time** [Measuring time by the stars]).

When astronomers measure a solar day, they use an imaginary line to the sun. But by the time the earth has rotated once in relation to an imaginary line to a star, it

has moved westward along its orbit. The sun is then about one degree east of its position at the start of the earth's rotation. The earth needs additional time to rotate eastward to bring it back to the imaginary line to the sun. As a result, a *mean* (average) solar day is 3 minutes 56.55536 seconds of mean sidereal time longer than a sidereal day. A sidereal day equals 23 hours 56 minutes 4.09054 seconds of mean solar time.

In addition to the sidereal day, astronomers also identify other periods of sidereal time. The *sidereal year* is the time that the earth takes to travel around the sun and return to the same point in space relative to the stars (see Year). The *sidereal period* of a planet is the time elapsing between two successive *conjunctions* (apparent close approaches) between the planet and a specified star. The sidereal period accurately measures the time a planet takes to orbit the sun.

See also **Moon** (The orbit of the moon).

Sidney, Sir Philip (1554-1586), was an author, courtier, and soldier during the reign of Queen Elizabeth I of England. He became famous for his literary criticism, prose fiction, and poetry.

Sidney was born in Penshurst in Kent. He travelled widely and was popular at court. In *The Defence of Poesie* (1580?), Sidney championed "right" poetry—that is, fiction—against a variety of its enemies. This was the first major literary criticism in English. Sidney opposed Queen Elizabeth's proposed marriage to the Duke of Anjou in 1580. He went into temporary retirement at the home of his sister Mary, Countess of Pembroke. For her amusement, he wrote a romantic prose and verse narrative *Arcadia* (1580). He later made major revisions, but the countess edited the work into its final form.

Sidney's greatest work is *Astrophel and Stella*, which consists of 108 sonnets and 11 songs. This sequence—written in the 1580s—is one of the great works produced during the Elizabethan fashion for sonnet cycles.

Sidney joined his uncle, Robert Dudley, Earl of Leicester, in advocating a militantly Protestant foreign policy. In 1585, Sidney became governor of Flushing in the Netherlands. He died of a wound in battle there the next year.

Sidon was an important manufacturing and port city in ancient Phoenicia. The present-day town of Sayda, Lebanon, occupies its site.

Sidon was most famous for its purple dye and blown-glass industries. The Greek poet Homer mentioned silver bowls of Sidon. Sidon was usually overshadowed in importance by the nearby Phoenician city of Tyre (now Sur, Lebanon), which was its chief commercial rival. But Sidon enjoyed a brief period of independent prosperity after Babylonia defeated Tyre in 573 B.C.

SIDS. See Sudden infant death syndrome.

Siegbahn, Karl Manne Georg (1886-1978), a Swedish physicist, received the 1924 Nobel Prize for physics for his work with X rays and a method of analysis called *X-ray spectroscopy*. He turned from an interest in electricity and magnetism to the study of X rays in 1914. He developed new types of X-ray spectrographs and improved X-ray tubes. With this more accurate equipment, he was able to make more precise measurements than had previously been possible. He also investigated the internal structure of atoms through the study of their X-ray spectra.

Siegbahn was born in Örebro, Sweden, and received his doctor's degree in 1911 from the University of Lund, in Sweden. In 1937, he became director of the Nobel Institute for Physics at the Stockholm Academy of Sciences. Siegbahn's son Kai won the 1981 Nobel Prize for physics for his contribution to the development of high-resolution electron spectroscopy.

Siegfried was a legendary hero in medieval German literature. As a young man, Siegfried had acquired the fabulous treasure of the Nibelungs and a cloak that made him invisible. He also killed a dragon and bathed in its blood, which made his body invulnerable. But a linden leaf had fallen onto a point in his back just between his shoulders, leaving the spot unprotected. Years later, Hagen, a member of the Burgundian court, killed Siegfried by thrusting a spear into the unprotected spot. Hagen later took the treasure from Siegfried's wife, Kriemhild, and hid it in the River Rhine.

Siegfried is the hero of the *Nibelungenlied*, an epic poem composed by an unknown author about A.D. 1200. Siegfried is known as Sigurd the Volsung in the *Volsunga Saga*, a prose story written in Iceland in the 1100s or 1200s. The German composer Richard Wagner drew upon both works in his cycle of four operas, *The Ring of the Nibelung* (1869-1876).

See also **Brunhild**; **Nibelungenlied**; **Sigurd**.

Siegfried Line was the name of two fortified lines of defence established by Germany in the 1900s. German generals Paul von Hindenburg and Erich Ludendorff had the first Siegfried Line built in the winter of 1916-1917, during World War I (1914-1918). The line stretched across northern France and Belgium. The Allies, who called the barrier the *Hindenburg Line*, smashed it near the end of the war.

During the 1930s, Nazi dictator Adolf Hitler built a new Siegfried Line along the border between Germany and France. This chain of forts and tank defences stood opposite the Maginot Line, a massive line of fortifications built by France (see **Maginot Line**). The Allies broke through Hitler's Siegfried Line during World War II (1939-1945). Parts of this line still stand.

See also **World War I** (The final stage; map).

Siemens is the family name of two brothers from Germany who were inventors and industrialists.

Werner von Siemens (1816-1892) built telegraph lines in Germany, Russia, and other European countries. With his brother, he developed electric railways and lighting, and helped lay the early deep-sea telegraphic cables. While in the Prussian army's engineering service, Siemens developed an improved electroplating process. Later, he invented a dynamo that his brother used to run railways. Ernst Werner von Siemens was born in Lenthe near Hanover, Germany.

Sir William Siemens (1823-1883) invented a regenerative gas-fired furnace in 1856 that led to the open-hearth steelmaking process. He took his brother's electroplating process to England to sell in 1843, and settled there. He was knighted as Sir Charles William in 1883. Siemens was born in Lenthe.

Siena (pop. 61,888) lies in the hills of Tuscany near Florence, Italy (see **Italy** [political map]). Its central square, the Piazza del Campo, is internationally famous. The City Hall overlooks it. Horses sponsored by districts in the city run races known as the *Palio* in this square each

year. Siena's Gothic cathedral is made of black and white marble, and is one of Europe's most famous medieval cathedrals. Siena has a university that dates from the 1200's. The city was the home of Saint Catherine, the patron saint of Italy. See also **Simone Martini**.

Sienkiewicz, Henryk (1846-1916), was a popular Polish novelist. He won the Nobel Prize for literature in 1905. His most celebrated novel is *Quo Vadis?* (1895). A story of Roman society under Nero, it was dramatized and made into films in a number of countries.

The novel *With Fire and Sword* (1890) was also popular. This book is the first part of a *trilogy* (three-part work) that describes society in Poland during the wars of the 1600's that were fought against the Cossacks, Turks, and Swedes.

Sienkiewicz was born in Wola Okrzejska, near Łuków. He became a leader of patriots working for Polish independence.

Sierra Leone is a small country on Africa's western "bulge," north of the equator. Sierra Leone provides a large portion of one of the world's most valuable treasures—diamonds. It is among the leading countries in the production of diamonds used for gems and also of diamonds used in industry. The diamonds lie in gravel deposits along riverbeds and in swamps in eastern parts of the country. About 70 per cent of the diamonds make gemstones, and the rest are less expensive diamonds used in industry.

Sierra Leone, a former British colonial possession, became independent in 1961. It remained a member of the Commonwealth of Nations. Freetown is the country's capital, largest city, and main port. The city was founded in 1787 as a settlement for freed slaves.

Government. A military government controls Sierra Leone. The Supreme Council of State (SCS) governs the country. The SCS can have no more than 30 members. The chairman of the SCS heads the government. A 19-member Council of Secretaries, appointed by the SCS, handles the administration of the government of Sierra Leone.

People. For Sierra Leone's total population, see the *Facts in brief* table with this article. Most men in Sierra Leone are farmers. But many grow only enough food for their families, and work during the dry season mining diamonds. Many of the women run profitable businesses selling goods in local markets. Freetown has many modern buildings (see **Freetown**). Many people in villages live in concrete block houses, and many of the

Facts in brief about Sierra Leone

Capital: Freetown.

Official language: English.

Area: 71,740 km². *Greatest distances*—north-south, 354 km; east-west, 306 km. *Coastline*—338 km.

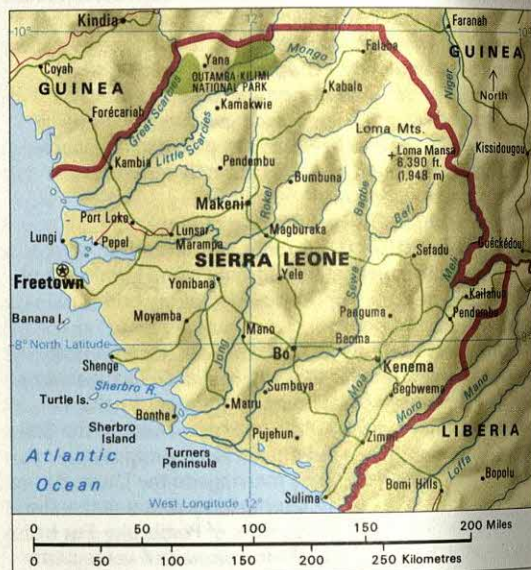
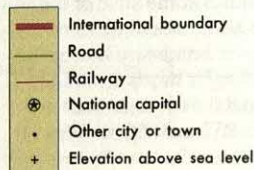
Population: *Estimated 1996 population*—4,863,000; density, 64 people per km²; distribution, 68 per cent rural, 32 per cent urban. *1985 census*—3,700,000. *Estimated 2001 population*—5,532,000.

Chief products: *Agriculture*—cacao, cassava, coffee, ginger, oranges, palm kernels, peanuts, piassava, rice. *Mining*—chrome ore, diamonds, iron ore, rutile.

Flag: Three horizontal stripes—green, white, and blue. See **Flag** (picture: Flags of Africa).

Money: *Currency unit*—leone. One leone=100 cents.

Sierra Leone



poor people in rural areas live in mud houses with corrugated iron or thatched roofs.

Most of Sierra Leone's people are black Africans who form 12 main ethnic groups. About a third of the people belong to the Mende group. They live in the southern part of the country. About a third of the people belong to the Temne ethnic group, and live in western Sierra Leone. Less than 2 per cent of the people are *Creoles*, who live in or near Freetown. These people are descended from freed slaves. English is the official language, but most of the people speak local African languages. The Creoles speak *Krio*, which is a local form of English.

Most of the people practise local religions. For example, the Mende believe *Ngewo* (God) created the world and everything in it. They place great value in *nomoli*, small humanlike figures carved in stone, which they find in the soil. They believe that possessing one will bring them an abundant yield of crops. No one knows for certain who carved the *nomoli*, but scholars believe they date from the 1400's. Some people, such as the Creoles, are Christians. Others are Muslims.

The law does not require the children of Sierra Leone to go to school. But about 40 per cent attend primary school, and approximately 15 per cent go to secondary school. The University of Sierra Leone is in Freetown.

Land. The country covers an area of 71,740 square kilometres. Freetown lies at the end of the Sierra Leone Peninsula. The Sierra Leone mountains rise to about 910 metres above sea level there. Swamps cover most of the coastal region, and extend about 32 kilometres inland.



Sierra Leone is the world's leading exporter of *piassava*, a fibre from the raffia palm used to make brushes.

Inland from the swamps, a coastal plain extends as far as 160 kilometres in the northern part of the country. This plain slopes up to a region of plateaus and mountains in the northeast that covers about half of the country. The mountains rise to more than 1,800 metres near the eastern border with Guinea. Loma Mansa, 1,948 metres, is the country's highest point. Gravel or sandy soil, on which only short grass grows, covers more than half the country.

Sierra Leone has a rainy, tropical climate. The dry season lasts from January to February in the south, and from December to March in the north. Freetown receives about 366 centimetres of rainfall a year. Only a narrow strip in the north has less than 200 centimetres of rainfall a year. Temperatures average from 25° to 27° C except in the extreme north, where greater variation occurs.

Economy. Farmers of Sierra Leone produce a wide variety of crops. But poor soil, the dry season, and the use of traditional farming methods keep crop yields low. Little effort is made to keep the soil fertile. As soon as the soil wears out on one plot, a farmer moves to a new area, clears the land, and plants a food crop.

Rice is the main food crop. Farmers also grow oranges, peanuts, tomatoes, and *cassava* (a plant with roots similar to potatoes). For export, they grow coffee; ginger; *cacao* (seeds used to make chocolate); *kola nuts*, which are used to make soft drinks; and *palm kernels* (palm seeds that contain a valuable oil). Sierra Leone is the world's leading exporter of *piassava*, a fibre from the raffia palm used in making brushes. People catch large amounts of fish called *shad* along the coast.

Diamonds make up about half the total value of Sierra Leone's exports. Diamonds are mined by a British company, Sierra Leone Selection Trust, Ltd., and by many independent, licensed Sierra Leone diggers. The British

firm is permitted to work in only a small part of the field, an area of about 736 square kilometres. The diggers may work in areas covering about 24,600 square kilometres. The government tries to control the quantities of diamonds mined, but many people mine diamonds illegally and smuggle them out of the country.

Sierra Leone's mineral resources also include iron ore, bauxite, and rutile. Bauxite is used in making aluminium, and rutile contains the important metal titanium. Bauxite is the second most important export.

Sierra Leone's only railway line links the coast with iron ore deposits at Marampa. Most of the country's roads are unpaved. However, they are fairly well maintained in spite of heavy seasonal rains. Less than 1 per cent of the people in Sierra Leone own a car. In rural areas, pickup trucks fitted with rows of seats provide much of the transportation. Buses also provide rural transportation. Buses and taxis operate in the cities. About 800 kilometres of rivers are navigable by small craft for three months each year. Freetown has an international airport.

History. Historians know little about Sierra Leone before 1460, when Portuguese sailors visited the area. In the 1500's, European trading ships began stopping there. The Europeans shipped many of the people from this area to America as slaves.

About 1725, Fulani people who lived east of present-day Sierra Leone began a holy war to convert their neighbours to the Islamic religion. As the Fulani moved westward, many other peoples also migrated toward the coast and settled in what is now Sierra Leone.

In 1787, Granville Sharp, an Englishman opposed to slavery, settled about 400 freed black American slaves on land where Freetown now stands. The settlers suffered from hunger, disease, and warfare, and the settlement almost died out. The British government made the slave trade illegal in 1807. The next year, the British government made the Sierra Leone Peninsula a colony. The British freed slaves from the slave ships of many nations, and settled them in the colony. British influence gradually spread inland. In 1896, the British established a protectorate over an area that, with the colony, had almost the same borders as present-day Sierra Leone.

Between 1896 and 1961, Sierra Leone moved gradu-



Freetown is Sierra Leone's capital and trade centre. The city was founded in 1787 as a home for freed slaves.

ally toward self-government. In 1961, it became a completely independent nation headed by a prime minister. Sir Milton Margai, the first prime minister, died in 1964. His brother, Sir Albert Margai, succeeded him. Political leaders struggled for power after indecisive parliamentary elections in 1967. Army officers then took over the government, dissolved the legislature, and suspended the Constitution. In 1968, the military government was overthrown. Siaka Stevens became prime minister and head of a new civilian government. In 1971, the legislature rewrote the Constitution and made Sierra Leone a republic, with Stevens as president.

A new Constitution adopted in 1978 made the All-People's Congress the only legal political party. Economic problems caused some discontent with Stevens' rule. But he remained president until he retired in 1985. Major General Joseph Momoh, commander of the armed forces, succeeded him.

In 1991, Sierra Leone adopted a Constitution that legalized opposition political parties. Multiparty elections were planned for 1992. But in April 1992, soldiers led by Captain Valentine Strasser overthrew Momoh and took control of the government.

Also in 1991, an uprising against Momoh, led by Corporal Foday Sankoh, broke out. After Momoh was overthrown by Strasser, Sankoh's forces began fighting the new government. The fighting has resulted in thousands of deaths. Rebel forces from Liberia have aided Sankoh in the fighting.

Sierra Madre, a name often used for mountain ranges, is Spanish for *Mother Range*. Sierra Madre is the name of mountain ranges in Spain, Mexico, and on Luzon Island in the Philippines.

The Sierra Madre mountains in Mexico form the edge of a wide central plateau. The Sierra Madre Oriental (east) lies on the east side of the plateau, toward the Gulf of Mexico. The Sierra Madre Occidental (west) borders the plateau on the west. Canyons and deep deposits of volcanic material make it difficult to cross. Part of the Sierra Madre Occidental extends north into Arizona and New Mexico in the United States. See **Mexico** (terrain map).

Sierra Nevada. See **Spain** (The Meseta).

Sieve of Eratosthenes is a method developed by the Greek mathematician Eratosthenes for identifying *prime numbers*. These are numbers other than 1 that can only be divided evenly by 1 and themselves. Today, electronic computers can be used to identify prime numbers, but the system still resembles the method used by Eratosthenes.

To find prime numbers with the sieve of Eratosthenes, first write the series of whole numbers starting with 2. Cross out every second number after 2. This eliminates all numbers that can be divided evenly by 2, except for 2 itself. Similarly, cross out every third number after 3. (Include those numbers that you have already crossed out.) This step eliminates all the numbers that can be divided evenly by 3, except for 3 itself.

The beginning of a sieve of Eratosthenes is shown below. It shows that 2, 3, and 5 are the first three prime numbers.

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 ...

In the next step, start with 5 and cross off every fifth

number. The process is endless, because there is no last prime number.

Sieyès, Emmanuel Joseph (1748-1836), popularly known as Abbé Sieyès, helped start the French Revolution with his booklet, *What Is the Third Estate?* In this booklet, published in 1789, Sieyès insisted that the people should have a voice in government.

Born in Fréjus, France, Sieyès became a priest. He was elected to the Estates-General in 1789 and served as president of the Assembly in 1790. Sieyès was a moderate and an expert on constitutions. He was a member of the Convention during the Reign of Terror (see **French Revolution** [Terror and equality]). Robespierre called him the *cunning fox* for his silent opposition to the Jacobins. Sieyès served as ambassador to Berlin in 1798, and a year later joined the French executive, the Directory. From 1815 to 1830, Sieyès was exiled by the restored Bourbon kings.

Sifaka. See **Lemur**.

Sight. See **Eye**.

Sigismund (1368-1437) was Holy Roman emperor from 1410 until his death. He also ruled as king of both Hungary and Bohemia. Sigismund helped end the *Great Schism*, a dispute in the Roman Catholic Church involving rival popes (see **Pope** [The troubles of the papacy]).

Sigismund was born in Nuremberg, Germany. He was the son of Holy Roman Emperor Charles IV. Sigismund was crowned king of Hungary in 1387. After he was elected Holy Roman emperor, Sigismund brought about the Council of Constance, a meeting of Catholic leaders. He was a leading force at the council, which settled the Great Schism in 1417 and elected Martin V as pope.

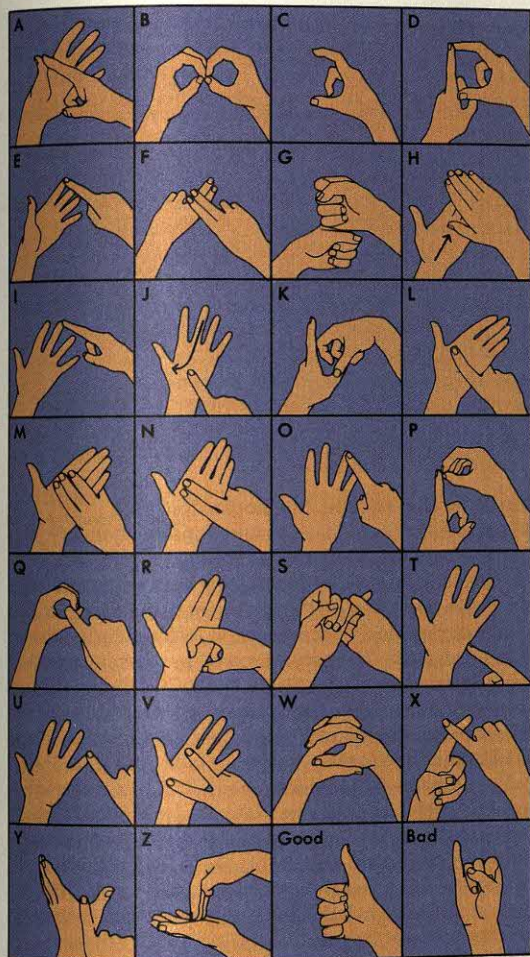
In 1420, Sigismund was crowned king of Bohemia. However, he was expelled by followers of John Hus, a Bohemian religious reformer who had been condemned to death by the Council of Constance. Sigismund had guaranteed Hus's safety but later approved his execution (see **Hus, John**). The Bohemians recognized Sigismund as king in 1436 after he agreed to demands on some church matters.

Sign language is a language of gestures and hand symbols. Deaf and hearing-impaired people use sign language. People with normal hearing also use it to communicate with deaf or hearing-impaired people.

Sign language is based on ideas rather than words. Each gesture expresses a particular idea or concept. For example, one gesture can be used to express the idea that something is real, or true, or correct, or has been promised.

Some words and names do not have equivalents in sign language. For these words, a manual alphabet—also called the *finger alphabet*—may be used. This system contains 26 hand symbols, one for each letter of the alphabet. The symbols are used to fingerspell words. They are also used in combination with gestures to express specific words or names.

When deaf people communicate with each other, they generally use a standard sign language, such as American Sign Language (ASL), developed in the United States, or British Sign Language (BSL), developed in the United Kingdom. In these standard languages, the key idea is signed first. For example, using BSL, a deaf person might sign first "name", then "what?" This is BSL for what would be spoken as "What is your name?"



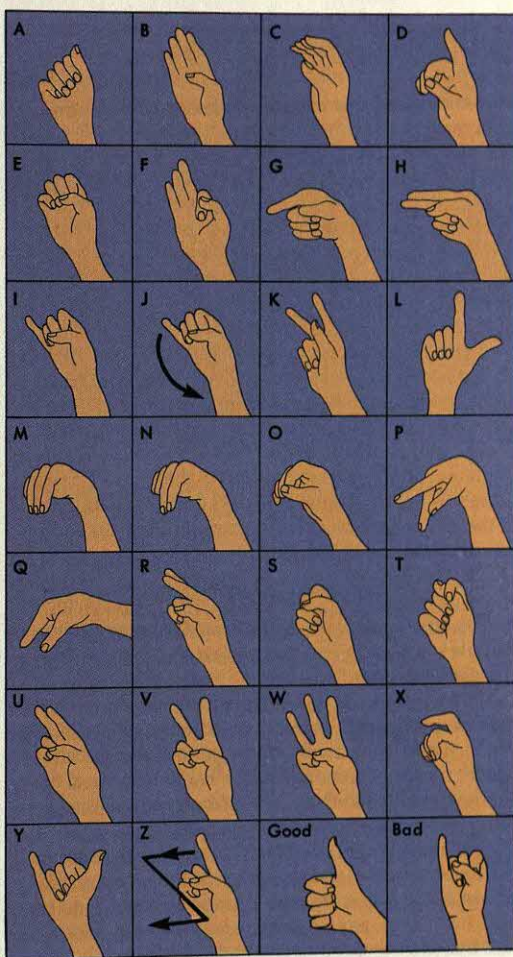
The **English hand alphabet** forms part of the British Sign Language used by most deaf people in Britain to carry on conversations. Unlike the systems used in other countries, the English system involves the use of both hands together.

When communicating with hearing people, deaf people try to modify their signing so that it more closely follows English word order. This process is called *signed English*. Many schools use a philosophy called *total communication*. This term means that every type of communication, including ASL or BSL, lip reading, and oral speech, is used as needed to express information and ideas.

See also **Deafness**.

Signalling is one way of passing information from one person or place to another. Signals are used when direct and unaided voice or direct written communication is impossible or undesirable. We use signals in everyday life. Traffic lights control the flow of cars across busy intersections. Signal lights tell you whether your computer is switched on or off. Doctors and dentists often give a signal with a buzzer to indicate they are available to see the next patient.

There are three main forms of signals: (1) electrical, (2) visual, and (3) sound. Various electrical, mechanical, and



The **American hand alphabet** is used in the United States and other countries. This system uses the fingers of one hand only. Each letter of the alphabet is represented by a different position of the fingers to spell out words.

hand devices are used to transmit signals. International codes—such as the international Morse code and the international flag code—have been developed for some kinds of signals. Such signals are the same throughout the world and can be understood anywhere. For more information on these, see **Flag** (The international flag code); **Morse code**.

Methods of signalling

Visual and sound signals of one kind or another have been used since ancient times. Early methods included smoke signals, drum signals, and beacon fires. Electrical signals were first used in the early 1800's.

Visual and sound signals still have many uses today. Sound signals are made with a variety of devices. These devices include bells, gongs, guns, horns, sirens, and whistles.

Visual signals are often made with flags. **Semaphore signalling** is done with two hand flags. The sender holds the flags in various positions to represent the letters of

the alphabet and to give several other meanings. *Flag hoist signals* are made by hanging coloured flags from crosspieces on the masts of ships. Both four-cornered flags and *pennants* (triangular flags) are used. Sailors send messages following the international flag code.

Visual signalling can be done with coloured lights, with each light having a different meaning. Lights are often flashed or blinked according to some code. Signals may be passed by reflecting sunlight with mirrors. *Pyrotechnics* (fireworks) provide signals in which colour is important. Pyrotechnic signals are made with various devices, including rockets, flares, smoke, and cartridges or shells fired from guns. Visual signals can also be made by hand and body movements, or by cloth *panels* (strips) laid flat on the ground or some other surface.

Electrical signals can be transmitted in various ways. These include radio, radar, television, telephone, teleprinter, and facsimile, or *fax*, machine. Communications satellites carry signals to any part of the world. Coaxial cables also carry several types of communication. Each of these means of electrical communication has a separate article in *World Book*.

Important uses of signals

This article discusses only a few of the many important uses of signals. For information on other uses of signals, see *Related articles*.

Military signalling. Armies use such modern electrical communications as radio, radar, telephone, and television. Radio is used most often, but it is also the least secure means of communication. Radio can reveal the sender's position to the enemy. When secrecy is vital, radio messages are often sent in code.

Armies rely mainly on electrical communications. However, they also use messengers and visual and sound signals. Visual signals include arm and hand signals, hand flags, panels, lights, and fireworks. Sound signals include horns, gunshots, and whistles.

Aircraft signalling. Radio signals are passed between ground stations and aircraft concerning take-off and landing instructions, the position of other planes, and weather information. Radio communication between pilots flying in the same group or formation is important. Some aeroplanes also have an *automatic direction finder*, or radio compass, and use omnidirectional radio range equipment. This equipment enables pilots to locate their position at all times. Radar is used to guide aircraft to safe landings in any kind of weather, to help aeroplanes land on aircraft carriers, and to guide military aircraft to their targets. Visual signals used to aid pilots include beacons, running lights, wind socks, and approach light systems at airports.

Marine signalling. Various means of electrical communication are used by both commercial and naval vessels. Radio is used extensively in ship-to-ship communication, and for controlling naval aircraft. Radio circuits connect ships at sea with stations ashore. Radar helps reveal the position of ships. Enemy submarines and explosive mines can also be detected by an echo-sounding device called *sonar*.

Lights, semaphore flags, and flag hoists are the most common means of visual signalling at sea. Sound signals include electrical sound-producing devices and bells, gongs, and whistles on *buoys* (floating markers)

that are operated by the motion of the sea. Lights and fog signals on lighthouses, lightships, and buoys warn that ships are approaching land or dangerous hidden objects. Lights are also used as running lights on ships, and as signal searchlights.

Distress signals. A ship or aircraft in need of help can send several internationally agreed upon distress signals. Two of the best known are the radio signal *SOS* in code, which is used at sea, and the aircraft call of *Mayday* sent over voice radio. Other well-known distress signals include a gun fired at short intervals; a continuous sounding of fog signals; coloured flares thrown from shells or rockets; the international flag signal *NC*; and flying the national flag upside down.

Related articles in World Book include:

Beacon	Heliograph	Semaphore	SOS
Codes and ciphers	Lighthouse	Sign language	Traffic
Fireworks	Morse code	Siren	Whistle
	Radio (Uses)		

Signs of the zodiac. See *Zodiac* (picture).

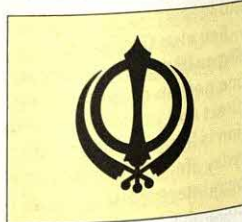
Sigurd is the Scandinavian name for the legendary German hero Siegfried. Stories about him probably originated in the A.D. 400's and soon reached Scandinavia. They were given poetic treatment in the *Elder Edda*, a collection of poems composed in Iceland during the 1000's and 1100's. The prose *Saga of the Volsungs*, written in Iceland during the 1100's or 1200's, tells the full stories. See also *Edda*; *Nibelungenlied*; *Siegfried*.

Sihanouk, Norodom. See *Norodom Sihanouk*.

Sikhism is one of the religions of India. Its believers call themselves *Sikhs*, which means *disciples*. Sikhs follow the teachings of 10 *gurus* (spiritual teachers). The Sikh holy book, the *Guru Granth Sahib* (The Revered Book), or *Adi Granth* (First Book), includes the teachings of some of the gurus and other Sikh teachers. About 14 million Sikhs live in India, the majority of them in the northern state of Punjab.

The first Sikh guru, Nanak, was born into a Hindu family in 1469. Nanak preached that there is one God who is the invisible creator and present everywhere. Nanak criticized Hindu and Muslim religious practices that he said emphasized outer forms over inner spiritual awakening. He instructed his followers to be aware of God's presence by rising early, bathing, meditating on the divine name, and directing each day's activities to God. By remembering God in this way, and by living a good and simple life, people could free themselves from the cycle of *reincarnation* (see *Reincarnation*). According to Sikh belief, a person's actions (*karma*) determine whether the soul will enter the next life as a plant, animal, or human being. Only someone who reaches a higher state of spiritual development can be free from experiencing further earthly lives.

In 1526, northern India was conquered by Muslims from what is now Afghanistan, who founded the Mughal Empire. By the time of the 10th guru, Gobind Singh, the Sikhs had



The symbol of Sikhism consists of two curved swords, a double-edged dagger, and a discus. The symbol stands for bravery and spiritual power.



The holiest Sikh shrine is the Golden Temple in the sacred city of Amritsar, India.

to defend themselves from Muslim persecution. In 1699, Gobind Singh organized his followers into a military order called the *Khalsa* (Pure). Sikh men and women were initiated into the Khalsa by sharing a drink of sweetened water called *amrit*, a symbol of loyalty to the guru and hope for a higher spiritual existence. The ideal of the true Sikh became the "saint-soldier" of the Khalsa who combines the virtues taught by Nanak and Gobind.

In the early 1800's, the Sikh ruler Ranjit Singh established a Sikh kingdom in northern India (see **Ranjit Singh**). In 1849, the kingdom was conquered by the British, who controlled much of India. When India and Pakistan became independent nations in 1947, almost half the Sikhs lived in the area that became Pakistan. Many Sikhs fled to India to escape persecution.

By the 1960's, the Sikh community was playing a leading role in India's agriculture, business and professional work, and military life. In 1966, India made the state of Punjab smaller, leaving the Sikhs in the majority. Anandpur, where the Khalsa was founded, and the holy city of Amritsar lie in Punjab. See **Amritsar; Punjab**.

Many Sikhs demanded more control of Punjab. In 1984, Sikh rebels occupied the Golden Temple and the surrounding sacred buildings in Amritsar. An Indian army action to remove the Sikhs caused great damage and many deaths. The government set up military rule in the Punjab, and some radical Sikh groups continued their rebellion.

Sikkim is a state in northeast India. It lies in the eastern Himalaya, and contains Kanchenjunga, the highest mountain in India, and the third highest mountain in the world. Sikkim is the second smallest state in India.

People and government

The original inhabitants of the region, the Lepchas, now form the minority of the population, along with the Bhutia from Tibet. Their main religion is Lamaistic Buddhism (see **Lama**). The rest of the people are mainly Hindu immigrants from Nepal.

Sikkim was a kingdom until 1975, when it became an Indian state. Its present government is like that of any other Indian state. The governor is appointed by the president. A chief minister and his council of ministers



The people of Sikkim are an ethnic mixture of the Lepchas, the Bhutia from Tibet, and immigrants from Nepal.

are drawn from the majority party in the state legislative assembly, which has 32 members. Sikkim has one elected member in the *Lok Sabha* (lower house) and one nominated representative in the *Rajya Sabha* (upper house) of the Indian national parliament.

There are four districts in Sikkim. The district officer has the same duties as the collector in other areas. Each village has a head, or leader, and a *panchayat* (council).

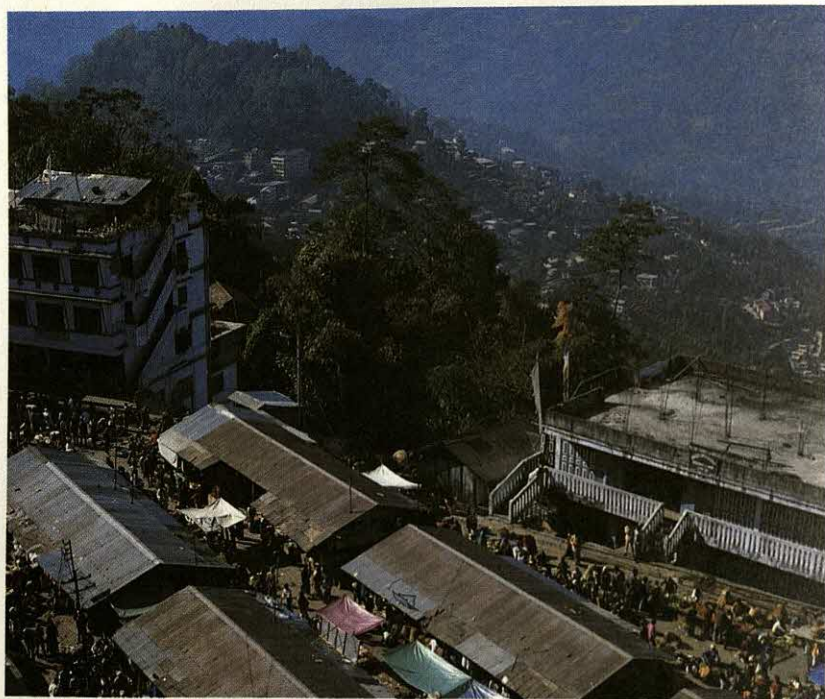
Economy

Farming is the main economic activity. Farmers grow their crops on terraced fields which have been created from the steep hillsides. They use irrigation wherever possible. Barley and wheat are the main winter crops and maize and rice are the main summer crops. Large cardamom, ginger, oranges, potatoes, and tea are grown in the foothills. Sikkim is India's largest producer of large cardamom (see **Cardamom**). The state's orchards provide fruit for a small fruit-canning industry. In summer, sheep and yak graze on the high pastures over 3,500 metres. Forests cover one-third of the state and have enormous economic potential.

Sikkim is rich in minerals and has deposits of coal,



Sikkim is a small Indian state lying in the mountains of the eastern Himalaya.



Gangtok, the capital of Sikkim, lies among mountains in terrain that is typical of the state. Gangtok is at about 1,500 metres above sea level.

copper, garnet, graphite, iron ore, lead, marble, pyrites, and zinc, all of which are mined. There are also high-grade reserves of gold and silver.

Traditional handicrafts and carpet weaving are important. The government of India has declared Sikkim an industrially under-developed area and has set up a flour mill and tannery, and cable, soap, watch assembly, and tea-processing factories.

There are no commercial flights to Sikkim and the nearest railway is at Darjeeling in West Bengal. There is a basic road network, but many villages can only be reached by footpath. Tourism is important to the local economy. Many people enjoy trekking in Sikkim.

Land

Sikkim lies in the eastern Himalaya between Nepal, to the west, and Bhutan, to the east. To the north are Tibet and China. The Indian state of West Bengal is to the south.

The state contains the upper valley of the Tista River, a tributary of the Brahmaputra. The *watershed*, which divides the river systems, forms the borders with Tibet and China, and Nepal. The Rangit and Rangpo rivers form the border with West Bengal. The Tista River Valley crosses the state from north to south and allows the monsoon rains to penetrate the northernmost parts. Tributaries of the Tista have cut many deep valleys out of the soft slate in the south.

The climate varies considerably. In the lower valleys it is subtropical. Above 1,000 metres, the climate is temperate. The tops of the higher mountains are permanently under snow. Sikkim is one of the most humid regions of the Himalaya. In Gangtok, at an altitude of 1,500 metres, the coldest month is January, when the average minimum temperature is 4° C and the maximum is 14° C. From April to October, the maximum temperature varies

little and is about 22° C. In May, the minimum temperature is 14° C. Annual rainfall is about 350 centimetres.

In the lowest parts of the state, the vegetation is forest of *sal*, an Indian hardwood, with about 660 species of orchids. Higher areas have tropical mountain evergreen forests and rainforests up to the treeline at 3,600 to 4,200 metres. Sikkim has a rich plant life. There are also over 500 species of animals and birds, including yaks in the north, and bears, red pandas, silver foxes, and leopards in the tropical forests. In the north is an area with thin grass cover. This area forms the transitional zone between the Himalaya and the Tibetan plateau.

History

The original inhabitants of Sikkim were the Lepchas, which means "ravine folk." They came to the area from the direction of Assam and Burma. From the 1200's, the Bhutia, a Tibetan people, moved into the area. They included the Namgyal clan, who arrived in the 1400's and gradually won political control over Sikkim. In 1642, Phuntsog Namgyal (1604-1670) became the *chogyal* (king). He presided over a social system based on Tibetan Lamaistic Buddhism. His descendants ruled Sikkim for more than 330 years.

During the 1700's, Sikkim suffered invasions from Nepal and Bhutan, and lost much territory as a result. Nepalese also migrated to Sikkim and settled there as farmers. By the 1800's, Sikkim's population was ethnically diverse.

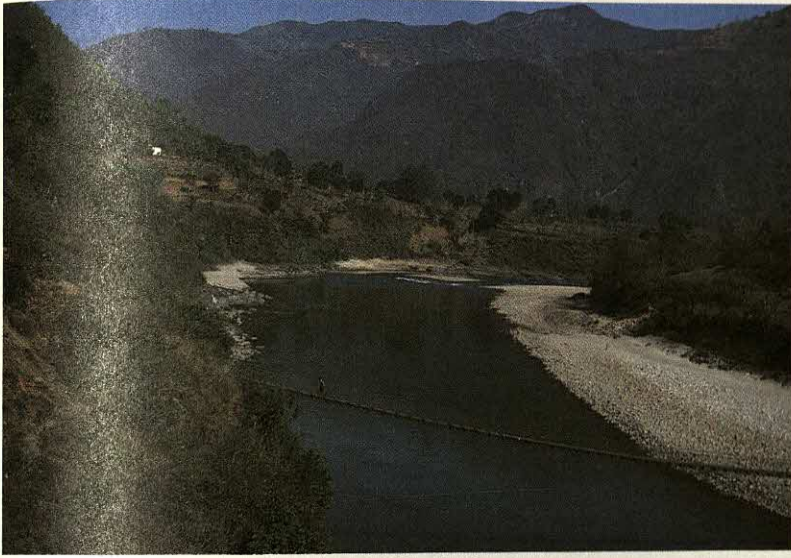
Facts in brief about Sikkim

Population: 1991 census—403,612.

Area: 7,096 km².

Capital: Gangtok.

Chief products: *Agriculture*—large cardamom, maize, oranges, potatoes, rice, tea, wheat. *Manufacturing*—distilling, textiles. *Mining*—coal, copper, gold, iron ore, marble, zinc.



Sikkim's border with the state of West Bengal to the south is mainly marked by the Rangit and Rangpo rivers.

cally very mixed, and internal conflict resulted. In 1814-1815, Sikkim assisted the British in a successful war against Nepal, and won back some of its lands. In 1835, the British East India Company purchased the health resort of Darjeeling from Sikkim. During the mid-1800s, Sikkim violently resisted attempts to bring it under British rule, but in 1861 it finally became a British protectorate. The British had access through Sikkim to Tibet, and Sikkim's independent status was recognized. In 1890, Britain and China signed a convention recognizing the border between Sikkim and Tibet. Later, the British installed a political official to help the chogyal of Sikkim run the internal and external affairs of the kingdom.

The Indian government took over responsibility for Sikkim's external affairs, defence, and communication in 1950. The struggle that had brought Indian independ-

ence in 1947 promoted a democratic upsurge in Sikkim. The chogyals lost their power as a result of the gradual introduction of a new democratic constitution. In 1973, India took Sikkim into the union as an associate member. In 1975, Sikkim became India's 22nd state.

See also **India**.

Sikorsky, Igor Ivanovich (1889-1972), an aircraft designer and manufacturer, was a pioneer in the development of multiengine aeroplanes, helicopters, and transoceanic flying boats. He designed the world's first four-engine aircraft in 1913. He produced a successful single-rotor helicopter in 1939 (see **Helicopter** [The first practical helicopters; picture]).

Sikorsky was born in Kiev, Russia (now in Ukraine). He was educated at the Petrograd Naval College and at engineering schools in Paris and Kiev. He first attempted to build helicopters, but failed because he lacked suitable engines. He then concentrated on fixed-wing aircraft and rose to a prominent position in Russian aviation, designing one of the most successful bombers of World War I (1914-1918). Sikorsky moved to the United States in 1919. He founded a company in 1923 which produced flying boats. Sikorsky then worked on designing helicopters.

See also **Aeroplane** (Other pioneer planes [picture]).

Silang, Diego (1730?-1763), a Filipino patriot, became the hero of the people of Ilocos province on the northern Philippine island of Luzon, when he led a revolt against Spanish rule in 1762. The British had captured Manila from the Spanish in that year. Silang allied himself with the British and began organizing the people of Ilocos to declare their freedom from Spain. The British commander made Silang governor of Ilocos and promised to send weapons. But the British aid never arrived. Silang held the territory against the Spaniards for three months. In May 1763, he was killed by a Spanish assassin. Silang's widow, Gabriela, continued the uprising. Her soldiers were defeated in a battle near the town of Vigan. She and 100 of her followers were hanged.

Silang was born in Aringay in the province of Pangasinan. In his early twenties he became a mail courier.



Igor Sikorsky, right, built and piloted the first successful four-engine aeroplane in 1913.

Silbury Hill, in Wiltshire, England, is the largest mound made by ancient people in Europe. It stands beside the Bath road, 10 kilometres west of Marlborough. The hill stands 40 metres high. Its base covers about 2 hectares. Around the hill is a deep ditch.

Professor R. J. C. Atkinson excavated Silbury Hill in 1969 and 1970. He discovered beneath the hill a circular area enclosing a *barrow* (mound used for burial). Tests on the radiocarbon content of materials discovered in the barrow showed that it was constructed in about 2100 B.C. (see **Radiocarbon**).

Silchester is a village in northern Hampshire, England. It occupies the site of the Roman town of *Calleva Atrebatum*, an ancient tribal capital. It has remains of Roman walls and a Roman road that ran from Calleva to Salisbury. The walls enclosed about 40 hectares. The population of Calleva was probably more than 1,000 people. Many Roman remains from the site may be seen by visitors to Reading museum, in Berkshire.

Silencer is a device that greatly reduces the exhaust noise of an engine. Silencers are used on nearly all motor vehicles.

The exhaust of a petrol engine originates in the cylinders. When the exhaust leaves the cylinders, it is at a much higher temperature and pressure than the outside air (see **Petrol engine**). If released directly into the air from the cylinders, the exhaust would expand suddenly, producing a loud, sharp noise. In the silencer and in other parts of the exhaust system, the gases are allowed to expand gradually and to cool. The pressure is thereby reduced, and little noise results when the exhaust is released.

Silesia is a region in southwestern Poland, eastern Germany, and the northern part of the Czech Republic. It includes the upper Oder River Valley and the Sudetes Mountains. Silesia covers about 49,000 square kilometres and has a population of about 10 million. Katowice and Wrocław, Poland, are the principal cities.

Silesia manufactures machinery, metals, and other products. Its minerals include coal and iron. Farmers in Silesia grow cereals, potatoes, and sugar beet.

The region became part of Poland in the 900's. Austria took over Silesia in 1526 and Prussia seized northern Silesia from Austria in 1742. In 1919, after World War I, Germany and Poland divided northern Silesia and southern Silesia became part of Czechoslovakia. Poland

gained control of the entire northern part in 1945, after World War II. In 1993, the Czechoslovak section of Silesia became part of the Czech Republic.

Silica is silicon dioxide, a chemical compound consisting of silicon and oxygen. Its chemical formula is SiO_2 . Silica occurs widely in rock-forming minerals called *silicates*, which make up much of the earth's crust and mantle (see **Earth** [Outside and inside the earth]). Such silicates as amphiboles, feldspars, micas, and pyroxenes consist of silica combined with various chemical elements. Quartz and a few other minerals consist entirely of silica.

Silica occurs in two forms, *crystalline* and *amorphous*. Crystalline varieties of silica include coesite, cristobalite, quartz, and stishovite. Amorphous silica forms include lechatelierite and opal.

Silica minerals have many uses. For example, quartz crystals serve as part of the transmitting equipment of radios and most kinds of radar. Special lenses for certain optical instruments are made from quartz. Quartz crystals also are used in various kinds of watches. Several varieties of quartz and opals are cut and polished as gemstones.

Related articles in *World Book* include:

Ceramics	Mica	Silica gel
Feldspar	Opal	Silicosis
Glass	Quartz	

Silica gel is a sandlike substance widely used as a demister. Each particle of silica gel has many small pores and thus a relatively large surface area. As a result, silica gel can *adsorb* (collect) large amounts of water vapour and certain other gases.

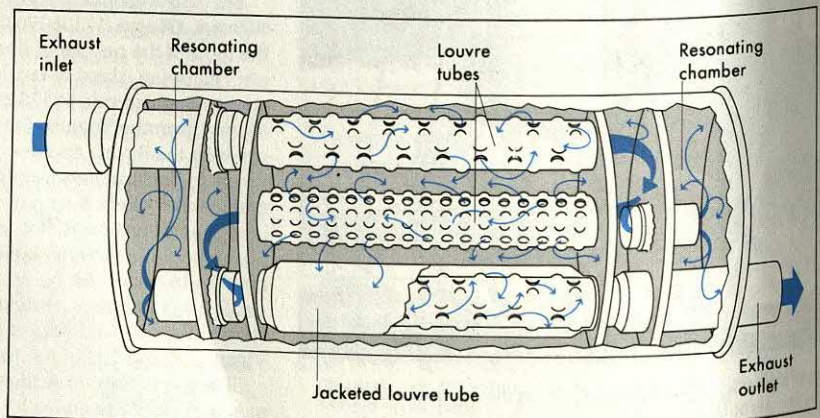
Silica gel has many uses. Small packets of it are packaged with certain foods to reduce moisture and preserve freshness. Manufacturers also use silica gel in making inks, paints, and *catalysts*. Catalysts are substances that speed up chemical reactions, for example, in pollution control systems and in petroleum refining.

Silica gel contains hydrogen, oxygen, and silicon and has the chemical formula SiO_2 . It is made by adding an acid to a solution of a compound called *sodium silicate*. The resulting gel is dried to produce coarse particles.

Silicate is any of a group of minerals that contain silicon, oxygen, and one or more metallic elements. Silicates make up about 95 per cent of the earth's crust. Soil consists chiefly of silicates, as do most rocks.

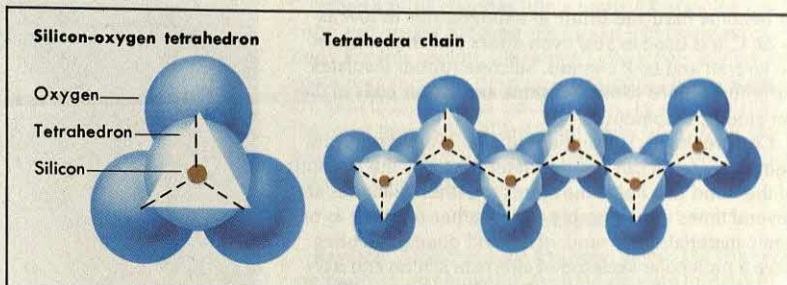
How a silencer works

A silencer reduces the noise made by exhaust gases from a petrol or diesel engine. The device passes the gases through perforated pipes called *louvre tubes*. These tubes enable the gases to expand and cool so that the gases do not produce a loud noise when they reach the outside air. *Resonating chambers* also help deaden exhaust noise by absorbing some of the sound produced by the gases as they flow through the silencer.



Silicate crystal structure

Silicate minerals have a structure comprised of units called *silicon-oxygen tetrahedra*. Each of these units consists of one silicon ion surrounded by four oxygen ions, which form a pyramidlike figure. Such units may exist independently, *right*, or they may be joined together as a chain, *far right*, and other more complex structures.



All silicates have a crystal structure composed of units called *silicon-oxygen tetrahedra*. Each of these units consists of one silicon ion surrounded by four oxygen ions, which form a pyramidlike figure with four triangular faces—that is, a tetrahedron. Such units may exist independently, or they may be linked with others, forming more complex structures. These structures, in turn, may be loosely held together by *cations* (positively charged atoms) of aluminium, iron, or other metals present in a given silicate mineral.

Silicates are classified according to the way their silicon-oxygen (SiO_4) units are arranged. An *independent tetrahedral silicate* consists of isolated groups of SiO_4 tetrahedra held together by metal cations. Olivine is a mineral of this type. A *double tetrahedral silicate* is composed of two tetrahedral groups. The mineral epidote contains such double tetrahedra. A *ring silicate* consists primarily of rings of three or six tetrahedra. The mineral beryl is an example of a six-membered ring silicate. A *chain silicate* has numerous tetrahedra linked together in either single or double chains. Amphiboles and pyroxenes are chain silicates. A *sheet silicate*, such as mica, consists of sheets of tetrahedra with metal cations sandwiched between them. A *framework silicate* is comprised of tetrahedra linked in three-dimensional networks that extend in all directions. Feldspar and quartz, the most abundant minerals in the earth's crust, belong to this group.

Silicon is a chemical element with the symbol Si. It is a hard, dark grey nonmetal. It makes up about 28 per cent of the earth's crust and is the second most abundant element. Only oxygen is more abundant. Silicon occurs only in combination with other elements, chiefly with oxygen as *silicon dioxide*. This compound, called *silica*, is the main ingredient of sand. It is also a major ingredient of various minerals that form rocks. These minerals include feldspar, pyroxene, and quartz. Lava from volcanoes consists mostly of molten silicon dioxide.

The atomic number of silicon is 14, and its atomic weight is 28.0855. Pure silicon melts at $1,410^\circ\text{C}$ and boils at $2,355^\circ\text{C}$. At 20°C , silicon has a density of 2.33 grams per cubic centimetre.

Silicon and its compounds have many important uses. Pure silicon is used in the manufacture of integrated circuits, transistors, solar cells, and similar electronic devices because it is a good *semiconductor* (see **Semiconductor**). *Silicon dioxide* is the main ingredient of glass (see **Glass**). *Silicon carbide*, one of the hardest materials known, is used to grind and polish other materials. Synthetic compounds called *silicones*, in which carbon and

silicon are combined with oxygen, have numerous industrial uses. For example, silicones can be made into synthetic rubber. Silicones are also used as insulators, lubricants, and water repellents. See **Silicone**.

Silicon was first isolated by the Swedish chemist Jöns J. Berzelius in 1823. He obtained it by combining potassium fluorosilicate with potassium.

See also **Element**, **Chemical** (tables); **Silica**; **Transistor**.

Silicone is any of a group of synthetic materials. It is unlike anything found in nature. Silicones are a cross between organic materials such as oil, rubber, and plastics; and inorganic materials such as sand, glass, and quartz. Their key material is silicon. With the exception of oxygen, silicon is the most abundant material in the earth's crust.

Uses. Silicones, which come in solid, liquid, and gaseous forms, are now in use in thousands of industries. Scientists are continually discovering new applications for silicones. As release agents, silicones keep bread from sticking to pans in commercial bakeries. Clean and smokeless, they work better than grease. They also keep tyres and other rubber and plastic parts from sticking in the moulds during manufacture. Silicone fluids are used in waxes and polishing agents for cars, furniture, plastic and enamel surfaces, and eyeglasses. Fabric and leather treated with silicone will not absorb water or water-based products such as ink and tomato juice. Repeated washing or dry cleaning will not remove the silicone. Yet silicone will not stiffen the fabric.

Many silicones are not harmful to the human body. They also are not affected by chemicals in the body. For these reasons, they are used in making artificial human parts, including breast implants and heart valves, which can be permanently implanted in the body.

Silicone oils and greases serve as permanent lubricants for clocks and ball bearings. Silicone water repellents keep brick and concrete walls dry in the rain. Silicones are also widely used as waterproof sealants for bathroom and kitchen tiling. Paints made with silicone resins do not blister and peel off at temperatures of 260° to 540°C . Outdoor weathering does not make them lose their gloss and colour. Silicone paints are often used on ships.

As electrical insulating materials, silicones make hard-working motors, generators, and transformers last 10 to 100 times as long as they ever did before. They enable a 7.5-kilowatt motor to do as much work as a 11-kilowatt motor.

Silicone rubber does not melt at oven temperatures

or become hard and brittle at temperatures as low as -79°C . It is used to seal oven doors and rocker boxes on aircraft and tank engines. Silicone rubber insulates communications cables on ships and motor coils in diesel-electric locomotives.

Composition. The amount of heat, weathering, and aging a material can stand is determined by the strength of the bond that holds the atoms together. Silicones are several times as heat-stable and weather-resistant as organic materials. Like sand, glass, and quartz, silicones have a molecular skeleton of alternate silicon and oxygen atoms. And the links in this chain are strong. The linkage, or bond strength, between silicon and oxygen is about one and a half times as great as the carbon-to-carbon bond that holds organic molecules together.

In making silicone products, "flesh" is put on the silicon-oxygen skeleton with organic groups that give the silicones such useful properties as water repellency, lubricating properties, flexibility, and ease of handling. Silicones can be made in the form of fluids, resins, and varnishes or gums. Silicone greases and compounds are made by adding fillers.

Silicosis is a lung disease caused by inhaling crystalline silica dust. Exposure to silica dust—and thus the risk of contracting silicosis—is especially high among iron and steel foundry workers, sandblasters, rock drillers, miners, and workers who produce pottery, glass, and abrasives.

There are three forms of silicosis: *simple*, *complicated*, and *acute*. After a particle of silica is inhaled, it eventually becomes surrounded by fibrous scar tissue. The scar tissue forms a small *nodule* (lump) in the lung. Simple silicosis is recognized by the presence of many small nodules on a chest X ray. It usually takes 10 to 20 years to develop. Simple silicosis generally does not affect the function of the lungs. It may, however, progress to complicated silicosis, in which nodules cluster together to form masses of fibrous tissue. When more than a third of a lung becomes fibrous, the patient experiences shortness of breath and abnormal lung function. Complicated silicosis sometimes leads to death. Acute silicosis develops much more rapidly than complicated silicosis and is usually fatal in two or three years. It causes the air sacs of the lungs to fill with fluid. Acute silicosis occurs in workers who are exposed to extremely high concentrations of silica dust, such as sandblasters and rock drillers.

There is no effective treatment for silicosis. Prevention is best achieved by using ventilation systems and engineering techniques that limit silica dust exposure in the workplace.

Silk is a strong, shiny *fibre* (threadlike substance) that is used to make cloth. Silk has a natural beauty that few other fibres can equal and is often called the *queen of fibres*. Silk fibre is made from the cocoons of caterpillars called *silkworms*. Many other animals, including spiders and lacewings, spin silk threads. But their silk cannot economically be made into cloth.

Silk is the strongest of all natural fibres. A thread of silk is stronger than the same size thread of some kinds of steel. Silk is highly elastic. It can be stretched and will still return to its original shape. Silk garments are extremely light in weight, and are warmer than cotton, linen, or rayon clothing. Dyed silk cloth has a deeper,



The luxurious qualities of silk have earned it the nickname *queen of fibres*. Dyed silk fabric has a radiant beauty that makes it a popular material for fashionable clothing.

richer appearance than most other dyed fabrics. Silk can be ironed easily, and it resists wrinkling.

Silk is used widely in making men's and women's fashionable clothing. It is also used in upholstery and curtain materials, especially in mixed fabrics.

China produces more raw silk than any other country. Japan ranks second in silk production. Other leading silk producers include Brazil, India, South Korea, and Thailand. The United States is the world's leading manufacturer of silk products.

Sources of silk

Cultivated silk is spun by silkworms that are reared on silk farms. Almost all commercial silk is cultivated. Most high quality cultivated silk is produced by the caterpillars, or larvae, of a moth called *Bombyx mori*. The first part of its name comes from *Bombycidae*, the family of moths to which it belongs. The last part comes from *Morus multicaulis*, the scientific name of the mulberry tree, on which it feeds.

The *Bombyx mori* is a rather large white moth, with black-lined wings. From wing tip to wing tip, the moth measures a little more than 5 centimetres. Its body is short and thick, and its legs are stout.

Wild silk, called *tussah*, comes from silkworms that feed chiefly on oak leaves. These worms grow wild, mainly in China and India. Tussah is difficult to bleach because its natural colour is tan or brown. It is less shiny than cultivated silk. Tussah is used as a filling in fabrics and is often blended with other fibres.

Rearing silkworms

The rearing of silkworms requires a great deal of care and patience. Silk farmers treat the *Bombyx mori* as carefully as they would a newborn baby. They rear it under carefully controlled temperatures. They protect it from mosquitoes, flies, and other insects.

Production of silkworms. In early summer, a female *Bombyx mori* lays from 300 to 500 eggs. It deposits them



Factory workers sort cocoons before beginning the process of *reeling* (unwinding) the long delicate threads. The threads of several cocoons are drawn together to form a strand strong enough for commercial use.

on special strips of paper provided by the silk farmer. The moth dies soon after it lays its eggs. The eggs undergo many tests to make sure they contain perfect, disease-free worms. Then they are put in cold storage. Early the next spring, the silk farmer puts the eggs in an incubator. An *incubator* is a device for keeping the eggs at a suitable temperature for hatching. About 20 days later, the eggs hatch into tiny silkworms.

Development of silkworms. The young silkworms are put on trays that are kept spotlessly clean to prevent disease. At first, the silkworms have enormous appetites. They eat almost continuously, both night and day. The silk farmer supplies them with fresh mulberry leaves every two or three hours.

The worms grow to about 70 times their original size and shed their skins four times. After four to five weeks, the silkworm is about 8 centimetres long and just over 2 centimetres thick. Its body has 12 sections and three pairs of legs.

Spinning the cocoon. When fully grown, the silkworm stops eating and is ready to spin its *cocoon* (outer wrapping). The worm creeps into a tiny wooden compartment containing twigs or stems of straw that the farmer has prepared. The worm spins a net or web to hold itself to a twig or stem. It then forms a cocoon, which is the silk. To do this, it swings its head from side to side in a series of figure-eight movements. Two glands near the silkworm's lower jaw give off a fluid that hardens into fine silk threads as it hits the air. At the same time, it gives off a gum called *sericin*. The sericin cements the two threads of silk together.

The silkworm spins the silk around and around its body, until all the fluid has been used. After about three days of spinning, the cocoon is completed. The worm then changes into a *pupa*, which is the third stage of its life cycle. If permitted to live, the pupa becomes a moth in about three weeks, thus completing the life cycle, or *metamorphosis*, of the *Bombyx mori*—egg, silkworm (caterpillar), pupa, and moth (see *Metamorphosis*).

When a pupa changes into a moth, it bursts the cocoon and breaks the long silk thread into many short ones. For this reason, silk farmers allow only a small percentage of pupas to develop into moths. These moths are kept to lay the next batch of eggs. To save the silk, the other insects are killed before they break their covering. Silk farmers usually kill the insects by placing the cocoons in a hot oven.

Processing silk

Reeling. After the pupa has been killed, silk workers are ready to *reel* (unwind) the long delicate threads of the cocoon. This is done in a reeling factory called a *filature*. The cocoons are soaked in basins of hot water to dissolve the gummy sericin that holds the threads together. Threads from several cocoons are unwound at the same time, because a single *filament* (slender thread) is far too fine to be reeled separately. As the cocoons bob about in the basin, their filaments are drawn together and pulled by pulleys through a tiny porcelain *guide*. The guide is much like the eye of a needle.

The melted sericin glues several silk filaments into a single thread, which is wound onto a reel. Later, the silk is removed from the reel and twisted into *skeins* (small coiled bundles). Fifteen double skeins or 30 small skeins are bound into a larger bundle, which is called a *book*. A bale of raw silk ready to be shipped to a mill for weaving contains about 30 books and weighs about 60 kilograms.

Throwing. The raw silk is now much stronger than it was when it left the cocoon. But it is still not strong enough to be woven into anything except the sheerest material. It is strengthened by a series of processes called *throwing*. The term comes from the Anglo-Saxon word *throw* (twist). Throwing is increasing the twist or adding strands and twisting them together.



Spools of silk thread in a Chinese factory are wrapped before they are shipped to a mill and woven. China produces more raw silk than any other country.



The life cycle of the silkworm moth

The eggs (1) of the silkworm moth hatch out after about 20 days into tiny caterpillars—silkworms (2). The silkworms grow by eating mulberry leaves. They have to shed their skins four times during the five distinct stages of their growth (3-7). They attach themselves to a twig or straw and then spin a cocoon of silk about themselves (8-9). Inside the cocoon, each silkworm becomes a chrysalis (10), eventually emerging as a moth (11), which makes a hole in the cocoon in order to emerge. Finally, the moths mate, and the female dies soon after laying her eggs. To save the silk, cocoons are immersed in hot water before the moths emerge. The fine silk filaments can then be unwound and collected.

The number of threads thrown together depends on the fabric to be woven. Most raw silk which is used to make the *woof* (crosswise threads) is thrown with a certain twist. But much silk used for the *warp* (lengthwise threads) is reeled in heavier sizes, and therefore need not be thrown.

Boiling off and weighting. When the silk comes from the throwing machines, there is still too much sericin on it. Workers boil the silk in a solution of hot soap to remove the sericin. This process is called *boiling off*. The removal of the sericin uncovers the natural beauty of the silk. Boiled-off silk is usually milky-white. The sericin can be removed either before or after weaving, depending on the type of fabric.

Boiling off causes the silk to lose about 25 per cent of its weight. Before World War II (1939-1945), silk fabrics were often *weighted* (loaded) with mineral salts to make up for this loss in weight. But heavily weighted silk cracks and tears much more easily than *pure-dye* silk. Since the mid-1900's, strict trade practice rules for the silk industry have been established. In a number of countries, silk is no longer weighted.

Dyeing. Brilliant dyes may be applied to silk yarn before it is woven. This type of dyeing is called *skein dyeing*. Some silk fabrics are dyed after they are woven. This process is called *piece dyeing*.

Weaving. Silk yarns are woven on looms much like those used for cotton and wool. Automatic power looms have replaced hand-weaving methods in almost all countries. Many silk fabrics, including damasks and heavy evening wear fabrics, are woven on Jacquard looms. Beautiful designs or patterns can be woven on these looms.

Douppioni are uneven, double silk threads. They come from two silkworms that have nested together and spun one cocoon around them. In processing, the double threads are not separated. Fabrics woven from douppioni thread have a knotted or twisted appearance. Douppioni are used for the filling in shantung and other rough weaves.

Spun silk. Not all silk can be reeled and thrown for weaving. When a moth bursts its cocoon, it breaks the one long filament into several short ones. These pierced cocoons and the beginnings and ends of reeled-off co-

coons are silk *wastes*. These fibres are spun into silk yarn. Spun silk is used for the filling in some silk, woolen, and cotton fabrics.

History

Discovery of silk. No one knows for sure when silk was discovered. According to a Chinese legend, it was discovered about 2700 B.C. in the garden of Emperor Huangdi. The emperor ordered his wife, Xilingshi, to find out what was damaging his mulberry trees.

Xilingshi found white worms eating the mulberry leaves and spinning shiny cocoons. She accidentally dropped a cocoon into hot water. As she played with the cocoon in the water, a delicate, cobwebby tangle separated itself from the cocoon. Xilingshi drew it out and found that one slender thread was unwinding itself from the cocoon. She had discovered silk.

Xilingshi persuaded her husband to give her a grove of mulberry trees, where she could grow thousands of worms that spun such beautiful cocoons. It is said that Xilingshi invented the silk reel, which joined these fine filaments into a thread thick and strong enough for weaving. Some stories also credit her with inventing the first silk loom.

No one knows how much, if any, of this story is true. But historians do know that silk was first used in China. The Chinese guarded the secret of the silkworm. Disgrace and death faced the traitor who disclosed the origin of silk to the outside world. Only the Chinese knew how to make silk for about 3,000 years.

Silk making spreads. China carried on a profitable silk trade with Western nations in the days of the Han Dynasty (founded in 202 B.C.). Traders from ancient Persia (now Iran) bought richly coloured silks from Chinese merchants. Camel caravans blazed routes across Asia, transporting silk from China to Damascus, the market place at which East and West met. From Damascus, silk

was taken to the Roman Empire, where there were riches to exchange for it.

As early as the 300's B.C., the Western world heard rumours of the strange worm that spun silk threads. But no one in the West saw the worm until about A.D. 550. At that time, Persia controlled all silk that came out of China. Persians sold it at extremely high prices.

The Roman, or Byzantine, emperor Justinian objected to paying high prices to the Persians. In about 550, he tried unsuccessfully to find a trade route from Constantinople (now Istanbul) to China that would bypass Persia. He later sent two monks to China as spies. Risking death, the monks smuggled out silkworm eggs and mulberry seeds in hollow bamboo canes. This adventure ended the Chinese and Persian silk monopolies.

During the next few hundred years, various peoples learned how to rear silkworms and take silk from the cocoons. The Muslims brought silkworms to Spain and Sicily in the 800's and 900's. By the 1200's, Italy had become the silk centre of the West. Silk weaving began in France in the 1500's. The French soon rivalled the Italians as silk manufacturers. Silk weaving became an important industry in England after a large number of skilled Flemish weavers entered the country in the late 1500's.

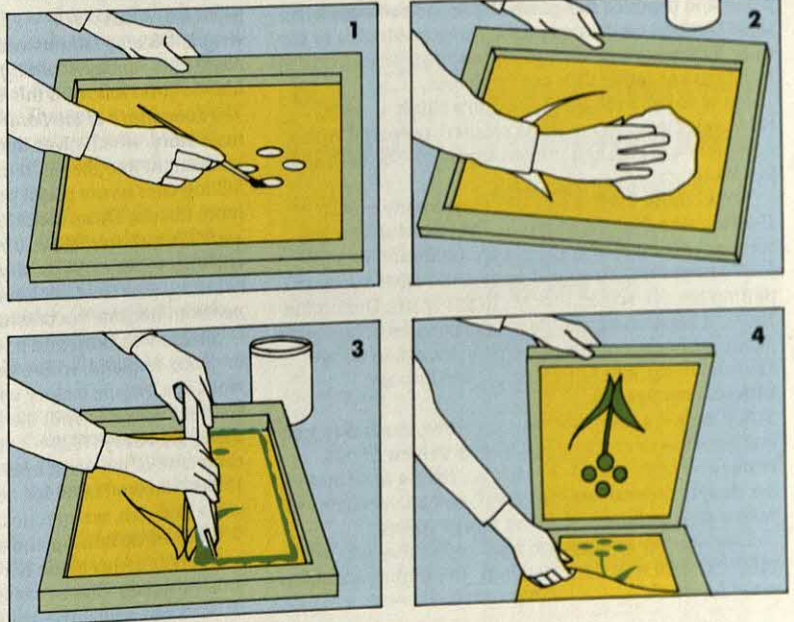
Silk making today. Before World War II, the hosiery industry was the biggest user of raw silk. Now most stockings are made of nylon. At one time, there was also a demand for silk lingerie and silk ribbons. Today these products are usually made of synthetic fibres. See *Synthetics*.

Most silk is used in making clothing, curtains, and upholstery. Silk has also been used with other natural and synthetic fibres to achieve new effects in fabrics.

See also *Cocoon*; *Moth*; *Mulberry*.

Silk-screen printing is a printmaking technique in which ink or paint is forced through a piece of silk onto

Silk-screen prints can be made in several ways. The pictures on the right illustrate a technique using a greasy liquid called *tusche*. First, the artist paints a design onto a screen with *tusche* (picture 1) and allows the liquid to dry. Then a glue-and-water mixture is applied. After the mixture dries, it is washed with a solvent (picture 2), which removes the *tusche* and its glue coating. The artist then applies ink with a squeegee (picture 3). The ink passes through the open areas but not the glue-covered areas onto the paper below. The artist removes the printed design (picture 4) and hangs the sheet up to dry.





The silky terrier

paper or other material. The silk-screen process is used commercially to print such items as billboard illustrations, package labels, and fabric designs. In art, silk-screen printing is called *serigraphy*. This article describes serigraphy.

To make a silk-screen print, the artist uses a piece of silk stretched tightly across a wood frame to form a screen. Such materials as nylon, polyester, or wire mesh may be substituted for silk. The artist places thick ink along one edge of the screen and then spreads the ink across its surface with a rubber blade called a *squeegee*. The squeegee distributes the ink or paint evenly and presses it through the weave of the silk onto the material below. In most cases, the material is paper, but artists also use other materials, including fabric, linoleum, glass, and wood.

The artist uses stencils to mask out parts of the design that are not to be printed. Most stencils are made of cut paper and produce designs with crisp, clean edges. Designs can also be painted on the screen with glue or lacquer. When printed, such designs appear to be made of brushstrokes rather than cutout shapes.

Many colours can be printed on a single surface. However, the screen must be cleaned, prepared with a new stencil, inked, and printed separately for each additional colour.

The Chinese used stencil printing as early as A.D. 1000 to make designs on fabric. The use of silk for the screen was begun in France in the 1800's and was primarily used for commercial purposes. Artists began exploring the silk-screen process in the 1930's. During the 1960's, it became a favourite printmaking technique with members of the pop art movement, including Robert Rauschenberg, and Andy Warhol (see **Pop art**).

Silkworm. See **Silk**.

Silky oak is a fast-growing, handsome, Australian tree that grows in dry subtropical forests of New South Wales and Queensland. It reaches a height of 40 metres, has deeply divided fernlike leaves, and bears masses of yellow-orange flowers on long flower spikes.

Silky oak has an attractive coloured timber which is yellow-brown with dark markings. The timber is used to make furniture.

Scientific classification. Silky oak belongs to the protea family, Proteaceae. It is *Grevillea robusta*.

See also **Tree** (Familiar broadleaf and needleleaf trees [picture]).

Silky terrier is a toy dog developed about 1900 in Sydney, Australia. The silky terrier is descended from a cross between the Skye, Cairn, Australian, and Yorkshire terrier. Australians keep the dogs as pets and once used them on farms to kill rats and snakes. Silky terriers have erect ears; *docked*, or cut off, tails; and long silky hair with tan-coloured markings. The dogs stand between 21 and 23 centimetres high at the shoulder, and weigh 4 to 5 kilograms.

Silliman, Benjamin (1779-1864), a leading American educator and scientist, founded the *American Journal of Science* in 1818. The journal at first published articles by scientists of many fields. Today, it contains only articles about geology. Silliman served as editor for more than 20 years. He also wrote a chemistry textbook and edited textbooks in chemistry and geology.

Silliman was born in North Stratford (now Trumbull), Connecticut, U.S.A., and graduated from Yale University, Connecticut, in 1796. In 1802, he became Yale's first professor of chemistry and natural history. Silliman helped make Yale one of the important centres of scientific education and research of the time. He was best known for his research into the chemical composition of a meteor that fell to the earth in 1807. Silliman's research helped prove that meteors are made of materials that exist on the earth. The mineral *sillimanite* was named after Silliman.

Sillimanite is an uncommon substance that belongs to the large class of minerals known as silicates (see **Silica**). Its chemical formula is Al_2SiO_5 . Sillimanite is sometimes called *fibrolite*. It may be brown, pale green, or white, and it has a glassy lustre. It occurs in central Europe, Brazil, and the United States. Sillimanite is named after the American scientist Benjamin Silliman (see **Silliman, Benjamin**).

Sillitoe, Alan (1928-), a British author and playwright, became famous with his first novel, *Saturday Night and Sunday Morning* (1958), about working-class life. He soon followed this with a collection of stories, *The Loneliness of the Long Distance Runner* (1959). The main story, which gives the book its title, offers an excellent insight into the mind of a boy at a borstal school. Sillitoe later wrote plays, poems, more short stories, and more novels. These include *Three plays* (1978), *The Rats and Other Poems* (1960), *The Ragman's Daughter* (1963), and *The Victory* (1982). *Saturday Night and Sunday Morning* and *The Loneliness of the Long Distance Runner* both became successful films.

Sillitoe was born into a working-class family in Nottingham, England, where he went to school. He started work in a bicycle factory when he was 14. He was later a wireless operator with the Royal Air Force in Malaya.

Sills, Beverly (1929-), an American singer, became one of the great operatic sopranos of the mid-1900's. She won fame for her extraordinarily flexible voice and rich, warm tones.

Sill's musicianship and ability to perform in a variety of operatic styles made her popular with both audiences and musicians. She became noted for her performances of works by such diverse composers as Gaetano Doni-

zetti, George Frideric Handel, and Giuseppe Verdi. Sills also earned recognition as a fine actress in such roles as Cleopatra in Handel's *Julius Caesar* and as Violetta in Verdi's *La Traviata*.

Beverly Sills's real name is Belle Silverman. She was born in New York City and received her training there. Sills made her operatic debut in 1946 and joined the New York City Opera in 1955. She sang with leading European opera companies. She made her Metropolitan Opera debut in 1975 in Rossini's *The Siege of Corinth*. Sills retired as a performer in 1980 to become director of the New York City Opera. She retired as director in 1989 and became president of the institution. Sills wrote two autobiographies, *Bubbles: A Self-Portrait* (1976) and *Beverly* (1987).

Silo is a storage bin for chopped green plants used as livestock feed. Silos make it possible for farmers to supply livestock with juicy, tasty feed all year. Before silos were invented, cows gave less milk during winter because they had no green grass to eat.

Farmers use machines to chop up the plants. The chopped material is called *silage*. Machines blow the silage in at the top of the silo. Many farmers use maize and juicy grasses called *sorghums* for silage.

If silage is packed properly, all air is forced out. Feed does not spoil in a silo, because moulds that cause feed to spoil cannot survive without air. Chemical changes that occur in the silage called *fermentation* also help prevent rotting. Acids produced by fermentation help to prevent the growth of moulds. If a feed does not have enough starch or sugar for fermentation, farmers may add hydrochloric acid, sulphur dioxide, sodium metabisulphite, or other acids to the feed to keep it from spoiling. Molasses or ground grains may be used to make *legumes* (pod plants) into silage. They contain starches and sugars that help to start fermentation.

The first silos were pits covered with boards. Then farmers started to build square, wooden silos above the ground. But the corners of the silo made it impossible to pack the feed tightly. Air got in, and much of the feed spoiled. In 1882, Franklin King, an American agricultural scientist, built a round silo. Round silos resist the pressure of tightly packed feed best. Today, tall round silos are built throughout the world. They are made of stone, brick, clay tile, sheet metal, concrete, or wood blocks. Airtight, glass-lined steel silos are widely used in areas where farmers use silage all year.

Other types of silos include *trench*, *bunker*, and *box* silos. The trench silo is made by digging a large trench, filling it with silage, and then covering it with a sheet of heavy plastic. The bunker silo is built above ground, and usually has wood or concrete sides. One or both ends may be left open. The box silo also is built above ground with poles and wood siding. Livestock can take feed from these types themselves.

Temporary *plastic silos* can be made by piling silage on a sheet of plastic placed on the ground, then covering the pile with a second sheet of plastic. After a vacuum pump removes all the air, the two sheets of plastic are sealed.

Silt is a fine-grained or muddy material made up of tiny particles of rock that settle at the bottom of rivers and other bodies of water. A material which sinks in water or air is known as *sediment*. Common examples of sedi-

ment include silt, sand, gravel, mud, and dust, or soil. Silt is made up of tiny particles ranging in size from 0.002 to 0.05 millimetre in diameter. Most lands with silt deposits are fertile.

Silver is a chemical element. It is a soft, white metal. Its atomic symbol, Ag, comes from the Latin word for silver, *argentum*. It was one of the first metals used by human beings. People have used silver for ornaments and for money since about 4000 B.C. Many beautiful objects, including jewellery, fine tableware, religious decorations, coins, and mirrors, are made of silver. Silver also plays an important role in dentistry, medicine, photography, and electronics.

Most countries of the world have deposits of silver and silver ore. However, mining silver is expensive, and the metal can be recovered economically in only a few places.

Silver in its pure form is called *metallic*, *free*, or *native*. Pure silver is extremely soft. As a result, a small amount of another metal—usually copper—is generally added to increase the silver's hardness and strength. For example, *sterling silver* is an *alloy* (mixture) of 92.5 per cent silver and 7.5 per cent copper. *Silver plate* is a term used to describe an object made of a base metal, such as steel, that is coated with a thin layer of silver or silver alloy.

Uses of silver. Silver, along with copper and gold, is called a *coinage metal*, and it has been used to make coins for thousands of years. In the past, some countries had silver coins that contained 90 per cent silver and 10 per cent copper. But the silver content has been reduced in many coins in recent years.

Silversmiths craft many art objects from silver. The metal is also used by the electrical and electronic equipment industry for wire and other items, because silver conducts electricity better than do other metals. Surgeons use thin plates, wires, and drainage tubes made

Leading silver-mining countries



Figures are for 1989. Source: U.S. Bureau of Mines.

How silver flatware is made

The production of a piece of high-quality silverware involves many steps. The process begins with an artist's design. Working from the design, a craftworker makes a steel tool called a *die*, which forms sheets of metal into desired shapes. The shapes are then trimmed, buffed to remove any roughness, and polished repeatedly to bring out the metal's natural lustre. The pictures below show some of the steps involved in making a piece of silver flatware.



A model is created by carving a design from a sketch into clay or plaster. It will serve as the pattern for the die.



A steel die for every piece is carved by hand. A blank piece of silver is pressed into the die to imprint the design.



Trimming removes excess silver from around the edges of the piece. The edges are then smoothed on an abrasive belt.



Polishing rubs out small imperfections. The piece is held against a rotating wheel and polished with oil and pumice.



Cosmetic treatment involves rubbing the piece with a powder called *rouge* to bring out shimmering highlights.



Final inspection ensures that the finished piece is free from flaws. Then the piece is weighed and sealed in plastic.

of silver during surgery, because silver helps kill bacteria. Dentists fill cavities with silver *amalgam*—a mixture of silver, tin, and mercury. Silver-cadmium alloys are used in the manufacture of bearings, and silver is also added to gold that is used for jewellery.

Silver compounds also have many uses. Compounds of silver include silver nitrate (AgNO_3), silver bromide (AgBr), and several silver oxides. Silver nitrate is one of the few water-soluble silver compounds, and is used to make silver plate and silver mirrors. Silver bromide plays an important role as the light-sensitive chemical in photographic film (see **Photography** [Exposing the film]). Silver iodide (AgI) is used as the cloud seeding material for artificially caused rain. Manufacturers of batteries use silver oxides to make small, powerful batteries for calculators, hearing aids, and watches.

Properties of silver. Silver has an atomic number of 47, and an atomic weight of 107.8682. Silver melts at 961°C and boils at 2193°C . At 20°C , it has a density of about 10.49 grams per cubic centimetre (see **Density**).

Silver reflects 95 per cent of the light that strikes it, making it the most *lustrous* (shiny) of the metals. Silver conducts heat and electricity better than any other metal does. It is second only to gold in *ductility* (the ability to be drawn out into fine wires) and *malleability* (the ability to be hammered into various shapes).

Silver, like gold, does not react chemically with most substances. However, the presence of sulphur compounds causes silver to develop a black or grey coating of silver sulphide (Ag_2S) called *tarnish*. Because polluted air contains these compounds, silver tarnishing is a greater problem today than in the past. Eggs tarnish silver spoons or forks because eggs contain sulphur compounds.

Sources of silver. Mexico leads the world in the production of silver, followed by the United States, and Peru.

Silver occurs in deposits of native metal and as silver ores. Native silver mines provide only a small amount of the world's silver. The most common silver ores contain

the mineral argentite or the compound silver sulphide. Silver often occurs along with such metals as copper, gold, lead, and zinc. Mining and processing of these metals produces about 80 per cent of the world's silver.

Extracting and refining silver. There are several methods of extracting silver from ores. Most of the world's silver is extracted from copper and lead ores. These ores are first crushed and then smelted, producing a mixture that contains the primary metal and small quantities of silver. In the process of refining copper, the silver is separated from the copper to form a mixture called *sludge*. The sludge is removed and treated with nitric acid to dissolve the silver. The silver is then recovered by *electroplating* (see **Electroplating**).

Silver is extracted from metallic lead ore by the *Parkes process*. In this process, zinc is added to *molten* (melted) lead ore to form a solid alloy with the silver contained in the ore. This solid zinc-silver alloy, which is less dense than molten lead, floats to the surface and is raked off. Heating the zinc alloy then removes the zinc from the silver.

Once extracted, silver is removed from the extracting solution. A process called *electrolysis* is then used to refine and purify the extracted silver. During electrolysis, the impure silver serves as the *anode* (positive electrode), and a strip of pure silver metal serves as the *cathode* (negative electrode). Refiners dip the two electrodes into a solution of silver nitrate and nitric acid. An electric current sent between the electrodes causes the anode, or impure silver, to dissolve. The impurities in the silver fall to the bottom of the solution, and pure silver crystals collect on the cathode. These crystals are scraped off, melted, and cast into bars of silver. See **Electrolysis**.

Related articles in World Book include:

Alloy	Metallurgy	Silver nitrate
Ductility	Money	

Silver fox. See **Fox**.

Silver nitrate is a chemical used in medicine and industry. Silver nitrate has the chemical formula AgNO_3 . It dissolves easily in water. It burns the skin and can cause severe poisoning or even death if swallowed. Doctors use silver nitrate to *cauterize* (burn) wounds to prevent bleeding or infection, and to remove warts. They use a mild solution of it to treat certain eye and skin diseases, and as an antiseptic. Some countries require that the eyes of newborn infants be treated with silver nitrate solution to prevent possible blindness.

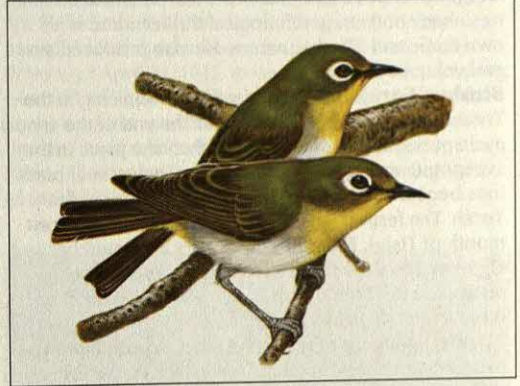
The photographic industry uses silver nitrate in making film. Most silver salts used in film are manufactured from silver nitrate. For example, silver bromide photographic film is made from silver nitrate and a potassium bromide solution. Gelatin, a protein substance, is then added to the solution to form a substance called an *emulsion* that coats the film (see **Photography** [Exposing the film]). Silver nitrate is also used to make mirrors and indelible ink, and in silver plating.

Silver can be purified by dissolving it in nitric acid and passing electricity through the silver nitrate solution. Pure silver forms at the *cathode* (negative electrode). Chemists use silver nitrate to help prepare other silver compounds and to identify chemicals in solution.

Manufacturers make silver nitrate by dissolving silver in nitric acid and then evaporating the solution. They sometimes melt silver nitrate and allow it to harden into

a crystalline mass. Silver nitrate in this form is also known as *lunar caustic*.

Silvereye, or *white-eye* is a small, greenish bird with white rings around its eyes. Silvereyes live in Africa, Asia, Australasia, and in some Pacific islands. There are over 250 species of silvereyes. The Australian eastern silvereye spread from Tasmania to New Zealand in 1850.



Indian silvereyes live in southern Asia. Like most species of silvereyes, they have white feathers around the eyes.

Silvereyes have short, pointed bills, and brush-tipped tongues which they use to "mop up" nectar from flowers. They also feed on fruit and insects. Silvereyes build cup-shaped nests between the outer branches of a tree. The largest species is the rare *Norfolk white-throated silvereye*, which measures 14 centimetres.

Scientific classification. Silvereyes belong to the family Zosteropidae. The eastern silvereye is *Zosterops lateralis*. The Norfolk white-throated silvereye is *Z. albogularis*.

Silverfish is a small, wingless insect found in cool, damp places. It is a common household pest. The silverfish is grey or silver in colour. It has two long antennae and three thin, bristlelike tail parts. It feeds on such starchy materials as books, wallpaper, clothing, and food.

Scientific classification. Silverfish belong to the family Lepismatidae. It is *Lepisma saccharina*.

Silversmith. See **Revere, Paul**; **Silver**.

Silverware. See **Silver** (pictures: How silver flatware is made).

Silviculture. See **Forestry** (Managing timber resources).

Simcoe, John Graves (1752-1806), was a British soldier and the first lieutenant governor of Upper Canada. He held office from 1791 to 1797. During the American Revolution he raised and commanded a corps of loyalists called the Queen's Rangers. As lieutenant governor of Upper Canada, he helped found Toronto. Simcoe was born in Cotterstock, England.

Simenon, Georges (1903-1989), a Belgian-born author, created the fictional detective Jules Maigret, an inspector with the Paris police force. Simenon wrote 102 novels and short stories that deal with Maigret.

In most Maigret stories, Simenon emphasized the motives behind a crime more than the crime itself. Instead of step-by-step detection of the criminal, Maigret

solves crimes using patience and insight into human nature. Simenon concentrated on creating realistic characters, and he vividly described the people, sights, and sounds of Paris and the small towns of France.

Georges Joseph Simenon was born in Liège, Belgium. He became a newspaper reporter and published his first novel at the age of 17. *Maigret and the Enigmatic Lett* (1931) was the first Maigret story to be published. Simenon also wrote over 300 other novels and short stories, many of them psychological thrillers, under his own name and 17 other names. He also produced several volumes of memoirs.

Simhat Torah is a Jewish festival of rejoicing in the Torah, or Law. Simhat Torah marks the end of the annual cycle of readings from the Torah that take place in the synagogue every Saturday morning. The cycle of readings begins again on the first Saturday after Simhat Torah. The festival falls on the 23rd day of the Hebrew month of Tishri. Tishri usually occurs in September and October. Jews in Israel and Reform Jews observe the festival on the 22nd day of Tishri. See also **Bible** (The Bible in worship); **Sukkot**.

Simile is a figure of speech used in describing or explaining something. It points out a likeness between two different objects or ideas by using a connective word. This connective word is usually *like* or *as*. An example of a simile would be, "He is as hungry as a horse," or "She ran *like* a deer."

Often a simile becomes so compact that we drop the connecting word. Then the simile becomes a **metaphor**. For example, the simile "He is *like* a fox" becomes a metaphor in "He *is* a fox."

See also **Figure of speech**; **Metaphor**.

Simmental. See **Cattle** (Simmental; picture).

Simon, Neil (1927-), is an American playwright. His almost unbroken succession of hit comedies and musicals has made him the most commercially successful playwright in American theatre history.

Marvin Neil Simon was born in New York City. His first plays were light, joke-filled comedies, beginning with *Come Blow Your Horn* (1961). He based *Barefoot in the Park* (1963) on his experiences as a newlywed in a New York flat.

In *The Odd Couple* (1965), Simon explored more serious themes about personal relationships. This play concerns two men separated from their wives. The men set up house together but repeat the mistakes that wrecked their marriages. *Last of the Red Hot Lovers* (1969) tells the adventures of a middle-aged husband who thinks society is experiencing a sexual revolution that has passed him by. *The Gingerbread Lady* (1970) describes the personal problems of an aging, alcoholic ex-singer. In *The Prisoner of Second Avenue* (1971), a married couple tries to cope with the problems of living in a large U.S. city. *Chapter Two* (1977) is a partly autobiographical comedy-drama about a writer who remarries after the death of his first wife. *Brighton Beach Memoirs* (1983), *Biloxi Blues* (1985), and *Broadway Bound* (1986) are autobiographical comedy-dramas about the playwright's experiences as an adolescent and a young man. *Plaza Suite* (1968) and *California Suite* (1976) are groups of one-act plays about love and marriage. Simon's other comedies include *The Star Spangled Girl* (1966), *The Sunshine Boys* (1972), and *Rumors* (1986).

Simon has written the stories for four musical comedies—*Little Me* (1962), *Sweet Charity* (1966), *Promises, Promises* (1968), and *They're Playing Our Song* (1979). Simon has also adapted several of his plays for the cinema. In addition, he has written original scripts for such films as *The Out-of-Towners* (1970), *The Heartbreak Kid* (1972), *Murder by Death* (1976), and *The Goodbye Girl* (1977).

Simon, Paul (1942-), an American singer, songwriter, and guitarist, and his childhood friend Art Garfunkel, formed one of the most popular folk-rock groups of the 1960's. Simon began a successful solo career in the 1970's.

Simon and Garfunkel first billed themselves as "Tom and Jerry," and in 1957 recorded a minor hit titled "Hey, Schoolgirl" while they were still in high school. Simon and Garfunkel made their popular breakthrough in 1965 with the success of the folk-rock version of their song "The Sounds of Silence." Simon wrote almost all their material, including the hits "Mrs. Robinson" (1968) and "Bridge Over Troubled Water" (1970).

Simon and Garfunkel separated in 1970. Simon's major solo success of the 1970's came with the album *Still Crazy After All These Years* (1975). In 1980, Simon wrote and starred in the film *One Trick Pony*. He also composed the soundtrack. He reunited with Garfunkel in 1981 for a concert in New York City's Central Park. The concert was recorded as an album and inspired a reunion tour. In 1986, Simon released the acclaimed album *Graceland*, which he made with black South African musicians. Simon was born in Newark, New Jersey.

Simon, Saint, was one of the 12 apostles of Jesus Christ. His name appears only in the four lists of the 12 apostles in the New Testament. Simon is called *Zelotes*, a Greek word meaning *The Zealot*, in Luke 6:15 and Acts 1:13. In Matthew 10:4 and Mark 3:18, he is called the *Cananaean*, probably the Aramaic equivalent of *Zealot*. This title indicates he may have been associated with radical Jewish revolutionaries known as the Zealots.

According to later tradition, Simon preached the Gospel in Egypt. He then travelled with Saint Jude to preach in Persia, where both were said to have been martyred. Simon's feast day in the Roman Catholic Church is shared with Saint Jude on October 28. The Eastern Orthodox Churches celebrate Simon's feast day on May 10.

See also **Apostles**.

Simon Peter. See **Peter, Saint**.

Simone Martini (1285?-1344), an Italian painter, was born in Siena, a leading art centre of the 1300's. His colourful, decorative, yet realistic style is the outstanding example of the Siennese school of painting.

Scholars know nothing of Simone's life until 1315. That year, he painted *The Virgin in Majesty*, a fresco (painting on damp plaster) in the Siena city hall. This fresco honours the Virgin Mary, the patron saint of Siena. Perhaps Simone's greatest work is the *Annunciation* (1333), a dramatic, richly coloured altarpiece painted for the Siena cathedral.

From about 1340 until his death, Simone worked in Avignon, France, which was the home of the popes at that time. He painted many works for the Palace of the Popes there. These paintings helped shape the naturalistic style of such Flemish masters of the 1400's as Robert Campin and Jan van Eyck.

Simonstown (pop. 5,130) is a town and naval base situated on Simon's Bay, which is part of False Bay near Cape Town in South Africa. It is on the eastern coast of the Cape Peninsula, about 40 kilometres south of Cape Town.

The town has 21 buildings that are more than 150 years old. Most of them are in the "historic mile" in St. George's Street. Admiralty House, the oldest building, dates from 1814. The harbour is a base for fishing boats and private yachts. Tourism is a major industry.

Simonstown was named by Governor Simon van der Stel, governor and commander of the Cape Colony from 1691 to 1699. In 1814, the harbour became the headquarters of Britain's Royal Navy as the base of their South Atlantic fleet. In 1957, Simonstown was handed over by Britain to become the operational headquarters of the South African Navy.

Simplon Pass and Tunnel are important gateways through the Swiss Alps. Napoleon built a military road over the pass in the early 1800's. The present road leading to the pass begins at Brig in the Rhône Valley. It reaches an elevation of 2,009 metres, then descends into the Lake District of northern Italy. The Simplon Tunnel, completed in 1906, is one of the longest railway tunnels in the world. It is 20 kilometres long, and has a maximum elevation of 705 metres. For location, see **Switzerland** (map).

Simpson, Bobby (1936-), an Australian cricketer, was captain of Australia in 39 tests. He first captained Australia in 1963. Simpson retired in 1968 but was recalled to captain Australia against India in 1978 at the age of 42. He played in 62 tests and scored 4,869 runs at an average 46.81. Simpson was a fine bowler and fielder as well as an outstanding batsman. He took 71 wickets at an average 42.26 and caught 110 batsmen. Robert Baddeley Simpson was born in Sydney.

Simpson, Sir George (1787?-1860), served as governor of the North American territories of the Hudson's Bay Company from 1826 to 1860. Simpson helped make the company one of the world's greatest fur-trading firms.

During most of Simpson's term, the company's land included a large part of what are now Canada and the Pacific Northwest region of the United States. As top official of the company, Simpson became known as the "Little Emperor" because of his firm rule. He established trading posts on the Pacific coast, developed friendly relations with the American Indians, and aided Arctic explorations.

Simpson was born in Loch Broom, in Scotland. He settled in Canada after joining the Hudson's Bay Company in 1820. Simpson played an important part in uniting the Hudson's Bay Company with its rival, the North West Company, in 1821. Later that year, he became governor of the company's northern territories. Simpson often made difficult journeys to inspect trading posts and forts. He was knighted in 1841.

See also **Hudson's Bay Company**.

Simpson, Sir James Young (1811-1870), a Scottish doctor, specialized in *obstetrics*, the medical treatment of childbirth. In 1847, he suggested the use of the drug chloroform to relieve the pain of childbirth (see **Chloroform**). Many people opposed this suggestion, but opposition disappeared after Queen Victoria gave birth to

her eighth child, Prince Leopold, under chloroform. Simpson was born at Bathgate, Scotland.

Simpson, Wallis Warfield. See **Edward VIII**.

Simpson and his donkey became famous for helping wounded Allied soldiers during the Anzac landing at Gallipoli during World War I (1914-1918).

John Simpson Kirkpatrick was born at Tyne Dock, South Shields, England, in 1892. He lived in Melbourne, Australia, until he entered World War I as part of the 3rd Field Ambulance company. Simpson's donkey was one of several that had been landed with their Greek drivers on April 25, 1915, to be used in carrying drinking water. The Greek drivers soon left, and most of the donkeys, regarded as useless without them, merely wandered. Simpson found one and called it *Duffy*. Together, he and the donkey carried wounded soldiers between Monash Valley and the beach.



A statue in Melbourne, Australia, honours John Simpson Kirkpatrick and Duffy, his donkey. They rescued many wounded soldiers at Gallipoli, Turkey, during World War I.

Simpson and his donkey camped at the Indian mule camp. They reported daily at the field ambulance. On May 19, Simpson was killed by a shot in the heart. Duffy went with the Indian mule drivers after the Anzac evacuation. A statue of Simpson and his donkey was erected in Melbourne.

Simpson Desert lies on the border of Queensland, South Australia, and the Northern Territory. It is about 320 kilometres long and 160 kilometres wide. The centre of the desert is an area of sand drift. The outer parts of the desert include bare, rocky hills, sand ridges that range up to 15 metres high, and rounded stones called *gibbers*.

See also **Northern Territory** (picture).

Sin, Jaime Cardinal (1928-), Roman Catholic archbishop of Manila, made a lasting contribution to the

history of the Philippines. He encouraged people to take part in the revolution of February 1986, which toppled President Ferdinand Marcos and returned democracy to the Philippines. See **Philippines, History of the**.

Jaime Sin was born in New Washington, on the central Philippine island of Panay. He was ordained a priest in 1954. In 1967, he became a bishop. He served as archbishop of Iloilo before becoming archbishop of Manila in 1974. In 1976, Sin was admitted to the Sacred College of Cardinals in the Vatican.

Sinai is the mountain on which Moses received the *Decalogue* (Ten Commandments) and learned much of the Hebraic law. Mount Sinai, also called *Horeb*, is located somewhere in the mountain district of the Sinai Peninsula, a triangle between the two northern arms of the Red Sea. For the past 1,500 years, scholars have considered Mount Sinai to be a 2,400-metre peak in the southern tip of the triangle. Today, many experts think it may be in the peninsula's northeastern part.

See also **Moses**.

Sinai Peninsula is the part of Egypt that lies east of the Suez Canal and the Gulf of Suez, and borders western Israel. It covers 61,100 square kilometres and has a population of about 200,000. For location, see **Egypt** (physical map). The Sinai Peninsula is a dry land with a few small oases. It has a sandy coastal plain in the north, a high limestone plateau in its centre, and mountains in the south. The Sinai produces petroleum, manganese, and other minerals.

The western part of Egypt and the Sinai Peninsula were first linked together as a province of the Islamic Empire in the A.D. 600's. In 1906, an agreement between Great Britain and the Ottoman Empire gave Egypt control over the peninsula. Israeli troops occupied the Sinai during the 1967 Arab-Israeli war. During the 1970's, Egypt and Israel reached agreements calling for withdrawal of the Israeli troops. The troops completed a withdrawal from the far western part of the peninsula in 1975. In 1979, they withdrew from all of the western Sinai. The Israelis completed their withdrawal from the Sinai Peninsula in 1982. See **Israel** (History [maps]).

See also **Egypt** (History).

Sinatra, Frank (1915-), ranks among the most famous singers in the history of popular music. Nicknamed "The Voice," he became well known for both his soulful ballad singing and his interpretations of rhythm songs. Since he made his film debut in 1941, he has appeared in more than 50 films. He won the 1953 Academy Award as best male supporting actor for his work in *From Here to Eternity*.

Francis Albert Sinatra was born in Hoboken, New Jersey, U.S.A., the son of a fire fighter. He sang with local bands and won an amateur show prize in 1937 before joining trumpeter Harry James' band in 1939. While touring with the band of trombonist Tommy Dorsey from 1940 to 1942, he gained great popularity with teenagers throughout the United States. Sinatra



Frank Sinatra

began his career as a solo singer in 1943, and later gained popularity with audiences of all ages.

Sinclair, Sir Clive Marles (1940-), a British company director, was a pioneer in the development and manufacture of microelectronic equipment. Through his British company, Sinclair Research, he became famous during the late 1970's and early 1980's for developing advanced, but low-priced, computers. Sinclair developed many other products, including a type of flat-screen television set.

Sinclair was born in London. He left school at the age of 17, and did not go to university. He founded Sinclair Radionics, which he led from 1962 until 1979.

In 1979, he became chairman of Sinclair Research. He was knighted in 1983.

Sinclair, Upton (1878-1968), was an American writer and reformer. Sinclair was an idealistic supporter of socialism and became famous as a *muckraker*. The muckrakers were writers in the early 1900's whose principal goal was exposing social and political evils.

Sinclair's work is uneven in quality, yet he is one of the most translated American authors. The impact of his fiction on American political history is perhaps greater than that of any other American novelist except Harriet Beecher Stowe, who wrote *Uncle Tom's Cabin*. Sinclair's best-known novel, *The Jungle* (1906), is a powerful naturalistic exposure of the wretched sanitary and work conditions in the meat-packing industry. *The Jungle* led to the passage of America's first pure food laws. In other novels, Sinclair attacked capitalistic society (*The Metropolis*, 1908), conditions in coal mines (*King Coal*, 1917), and the oil industry (*Oil!*, 1927).

Sinclair also wrote several nonfiction books exposing what he saw as the corruption that capitalism created in various areas of American life. For example, *The Brass Check* (1920) deals with journalism, and *The Goose-Step* (1923) with higher education.

From 1904 to 1953, Sinclair published the Lanny Budd series of 11 novels, named after the main character. The novels span American and world history from 1913 to 1949. The best-known novel in the series, *Dragon's Teeth* (1942), won the 1943 Pulitzer Prize for fiction.

Sinclair helped organize the American Civil Liberties Union and the League for Industrial Democracy. He ran unsuccessfully three times each for Congress and for governor of California. Upton Beall Sinclair was born in Baltimore, Maryland.

Sine. See **Trigonometry**.

Sinew. See **Tendon**.

Sing Sing is the name of a state prison in Ossining, New York, U.S.A. From 1970 to 1983, it was called Ossining Correctional Facility. The prison has its own school and factories. Sing Sing originally had a building for women. But the facility now has no women prisoners. Construction of Sing Sing began in 1825 with convict labour. Later, the prison was reorganized, and several new buildings were put up.



Sir Clive Sinclair



The city of Singapore is built around its harbour. Singapore is the busiest port in Southeast Asia. The city's tall buildings form an impressive skyline overlooking the harbour.

Singapore

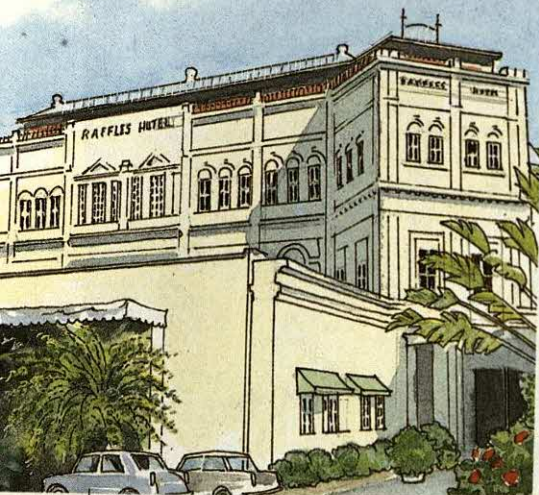
Singapore is a small island country in Southeast Asia. It lies at the southern tip of the Malay Peninsula where the South China Sea and the Indian Ocean meet. Singapore is about 140 kilometres north of the equator. Singapore has an area of 639.1 square kilometres. It consists of a large island and more than 50 smaller islands. The large island, which is also called Singapore, covers an area of 573 square kilometres. It is 42 kilometres long and 23 kilometres across at its widest point. About half of the smaller islands of Singapore are uninhabited. Some of the islands have been developed for recreation and tourism.

Singapore is a city-state (see *City-state*). Almost all of Singapore is *urbanized*—that is, covered by buildings or city facilities such as parks. Singapore is a crowded and bustling centre of manufacturing, trade, and finance. The main business and administrative section of the city is on the main island. There are many modern buildings which tower above the warehouses and docks of the port. Singapore is Southeast Asia's main port, and the busiest port in the world in terms of shipping tonnage. Singapore is one of the most prosperous countries in Asia. Its people enjoy high standards of health, education, housing, transportation, and telecommunications.



Chinese people form the majority of Singapore's population. Some Chinese people make colourful figures to celebrate the seventh-month festival.

Singapore *Busiest port in Southeast Asia: A mix of Eastern traditions and modern luxuries.*



The Skyline of Singapore, below, is dominated by modern skyscrapers. Many of these buildings tower over traditional Chinese shops and other ethnic structures.



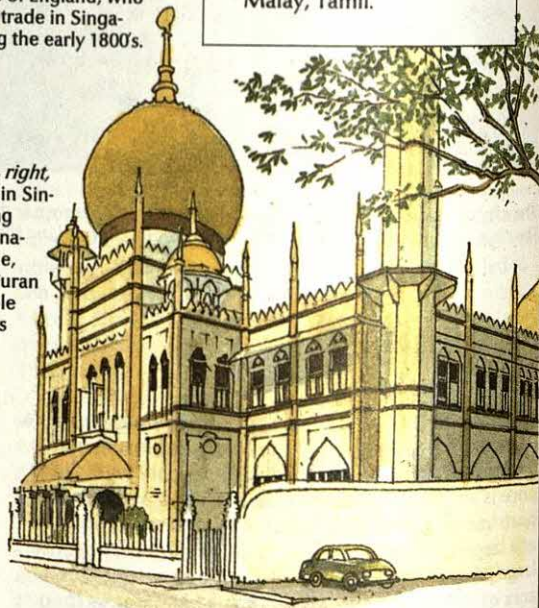
Chinatown, below, is Singapore's traditional Chinese neighbourhood. Temples, open-air markets, and rows of *shophouses* line its narrow streets. Shophouses are two-storey buildings with shops downstairs and living quarters upstairs.



The Merlion, above, a symbol of Singapore, is half lion, half fish. The statue shown here stands in Merlion Park and looks out over the harbour.

The Raffles Hotel, left, is a landmark of Singapore. It was named after Sir Stamford Raffles of England, who developed trade in Singapore during the early 1800's.

The Sultan Mosque, right, is the largest mosque in Singapore. It has gleaming golden domes and minarets. Inside the mosque, quotations from the Quran are inscribed on marble walls. The mosque was completed in 1928.



Small island country: large island and more than 50 smaller islands. Population of about 3,000,000 makes it one of world's most densely populated countries.

One of Asia's wealthiest nations. Diverse economy: centre of trade, finance, manufacturing.

Majority of people are Chinese. Minority groups include Malays and Indians. Four official languages: Chinese, English, Malay, Tamil.



1200's to 1300's
Kingdom of Singapore flourished as a sea-trading centre. Kingdom destroyed in 1377.

1824
All of Singapore came under British control.

1942
Japanese troops captured island during World War II and occupied it until 1945.

1963
Became part of Federation of Malaysia; withdrew in 1965 to become independent nation.

Singapore in brief

Capital: Singapore.

Official languages: Chinese, English, Malay, and Tamil.

Official name: Republic of Singapore.

Largest city: Singapore (2,308,200).



The Singapore flag. The red band symbolizes the brotherhood and equality of man. The white stands for purity and virtue. The crescent moon represents a young nation illuminated by the five stars of democracy, peace, progress, justice, and equality.



Coat of arms carries a shield with the moon and stars of the flag. *Majulah Singapura* means *Let Singapore Flourish*. The lion represents Singapore and the tiger a historical link to Malaysia.



The national symbol is a lion symbolizing courage, strength, and excellence.

Land and climate

Land: Consists of one large island and more than 50 smaller islands just south of the tip of the Malay Peninsula. Its closest neighbours are Malaysia to the north and Indonesia to the south.

Area: 618 km². *Greatest distances* (on Singapore island)—east-west, 42 km; north-south, 23 km.

Elevation: *Highest*—177 m (Timah Hill). *Lowest*—sea level.

Climate: Hot and moist all year round. Average temperature about 27 °C.

Government

Form of government: Parliamentary republic.

Chief executive: Prime minister, assisted by Cabinet.

Legislature: Single-house, 81-member Parliament, elected by the people; 6 more opposition MPs nominated.

People

Population: 1996 estimate—2,877,000. 1990 census—2,705,115. 2001 estimate—2,996,000.

Population density: 4,568 people per km².

Distribution: 100% urban.

Major ethnic/national groups: 78% Chinese, 14% Malay, 7% Indo-Pakistani, 1% Eurasian.

Major religions: 54% Buddhist and Chinese traditional religions, 15% Muslim, 13% Christian, 4% Hindu.

Population trend

Year	Population
1970	2,127,031
1980	2,413,945
1990	2,705,115

Economy

Chief products: *Agriculture*—pigs, chickens and eggs, vegetables, fruit, orchids. *Manufacturing*—electrical and electronic goods, including computers and parts, telecommunications apparatus, and audio and video equipment; shipbuilding and repair; petroleum products; machinery; garments; processed foods and beverages; wood products; rubber.

Money: *Currency unit*—Singapore dollar. One dollar=100 cents.

Gross domestic product: 1993 total GDP—U.S.

\$57,000,000,000. 1993 GDP per capita—U.S. \$17,598.

Foreign trade: *Major exported goods*—electrical and electronic equipment, petroleum products, machinery, garments. *Value of goods and services*—U.S. \$62,147,000,000.

Major imported goods—crude petroleum, machinery, parts for electrical and electronic goods, food. *Value of imported goods and services*—U.S. \$69,659,000,000. *Main trading partners*—European Union, United States, Malaysia, Japan.

History. Since prehistoric times, people have lived on what is now Singapore island. From about the A.D. 100's to the 1200's, the present-day city of Singapore was known as *Temasek*, or *sea town*. Temasek was an important link on the trade route between India and China.

The name *Singapore*, which means *lion city* in the Sanskrit language, has been used since the 1200's. The name was probably given because of the many tigers, mistakenly called lions, that inhabited the island. During the 1200's and 1300's, Singapore harbour served as a trading centre. Invaders from Java (now part of Indonesia) destroyed the settlement in 1377. During the 1800's and 1900's Singapore grew into a leading world trade centre.

Street markets in Singapore attract shoppers from many countries. About 3 million tourists visit the city yearly.





The Parliament building houses Singapore's legislature, which has 81 members.

Government

Singapore is a republic. An 81-member, one-house Parliament makes the country's laws. A prime minister and a cabinet carry out the operations of government. A president serves as head of state. The president has some controls over government finances and makes key civil service appointments. Since 1993, the president has been directly elected by the people to serve a six-year term. Elections are held every five years to choose members of Parliament (MPs). Every citizen over 21 years of age can vote. The president appoints as prime minister the MP who commands the confidence of the majority of other members.

The government has a major role in Singapore's economy. There are many official bodies which ensure the smooth development of the economy. The government decides what benefits, such as holidays and sick pay, must be provided for workers. A national pension or provident fund provides social security. Employees and employers contribute monthly to a central social security fund, managed by the government.

Political parties. Singapore's largest political party is the People's Action Party (PAP). It came to power in 1959. From 1968 to 1981, the PAP held all the seats in Parliament. Since 1981, it has held almost all the seats. There are more than 20 other registered political parties. In the 1988 elections, only 4 out of the 81 seats went to members of opposition parties. From September 1992, 6 new Nominated Members of Parliament (NMPs) were appointed as opposition members.

Courts. The Supreme Court and lower courts, including district and magistrate's courts, administer justice. The president, on the advice of the prime minister, appoints eight judges to the Supreme Court.

Armed services. Singapore has about 55,000 people in its army, navy, and air force. A further 200,000 people serve as reserves. Men aged 18 and over must serve from 2 to 2½ years in the armed forces.

International relations. Singapore belongs to the Association of Southeast Asian Nations (ASEAN), which also includes Brunei, Indonesia, Malaysia, the Philippines, and Thailand. See **Association of Southeast Asian Nations**.



The navy patrols in coastal waters and the South China Sea. Its ships include missile-armed gun boats.



Singapore's Supreme Court consists of the High Court, the Court of Appeal, and the Court of Criminal Appeal.



Buddhist temples serve Singapore's Buddhists, most of whom belong to the Mahayana school of Buddhism.



Deaf children attend special classes. Singapore has a highly developed social welfare system for handicapped children.

each religious group are observed as public holidays.

Education. About 90 per cent of the people of Singapore can read and write. This is one of the highest literacy rates in Southeast Asia. Children attend school from the age of 6, and many continue until 16. Primary education is free for six years for all children who are citizens of Singapore. Besides English, children also learn one other official language. About 50 per cent are literate in two to three languages. Colleges of higher education include the National University of Singapore, the Nanyang Technological University, and several polytechnics.

Clothing. Singapore's ethnic groups create a variety of cultures within the country. Most people wear West-

ern style clothing, but some Indians and Malays prefer their traditional dress.

Food. Restaurants in Singapore offer a variety of Chinese, Indian, and Malay dishes. Western foods are also available, including American-style fast foods. The larger hotels and restaurants also serve a variety of international foods including Mexican, Thai, and Vietnamese.

Culture. Art, music, and theatre reflect the cultures of the various groups. Cultural events include Chinese operas, Indian dancing, and Malay dramas. Performances by the Singapore Symphony Orchestra are also popular. A festival of arts staged every two years attracts international groups and artists to Singapore.



A Chinese opera is staged in the Tiger Balm Gardens. Arts and cultural festivals are encouraged by Singapore's Ministry of Community Development, and other groups.



Singapore's port is the busiest in Southeast Asia. Small craft crowd the harbour, which is visited each year by more than 30,000 vessels.

City

The city of Singapore lies on the southern coast of Singapore island. More than 90 per cent of the country's people live in the city. The city is built around its harbour. Singapore is the world's busiest port in terms of tonnage. Warehouses and concrete docks line the port. Singapore is a *free port*—that is, goods can be unloaded, stored, and reshipped without payment of import duties. In the crowded commercial district, modern skyscrapers tower over traditional Chinese shops. Singapore's oldest buildings date from the 1800's. One example is the National Museum.

Like many other cities with a colonial history, Singapore developed around its harbour. The British began the development of Singapore's port in the early 1800's. Immigrants settled around the port area. Colonial planners allocated a separate section of the city to each of the major ethnic groups.

Housing. In Chinatown and in other ethnic sections, people built *shophouses*. These buildings, usually two storeys high, were built on long narrow plots of land. The ground floor was used for business purposes—the shop—and the upper floor as living space—the house. From this comes the name—"shophouse." The shop had a narrow front opening onto the street. The rest of the building stretched back as much as 65 metres, and was used for storage. Many shophouses can still be seen.

During the late 1800's and 1900's, Singapore's trade expanded. More and more migrants arrived in the country. Many of these new settlers crowded into the central area. People added extra rooms on top of or on either side of existing shophouses. They divided up their living space into tiny cubicles. In this way, a building designed for one family became home to as many as seven families. This overcrowding caused public health and sanitation problems.

People in rural districts traditionally lived in *kam-*



Older housing includes shophouses, which people use both as residences and business quarters.



New public housing is provided by the Housing and Development Board. The Bishan West Estate is strikingly modern.



The Clifford Centre is a waterfront development in Singapore.

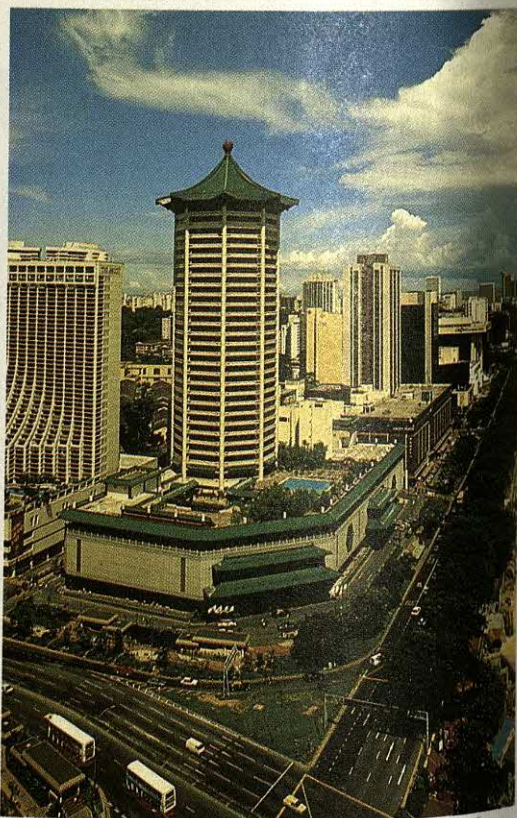
pongs (small villages). At one time, they lived in wooden houses with roofs of palm thatch, called *attap*. Later roofs were made of zinc metal sheets instead of thatch. Many of these country people made a living in market gardening or fishing.

By the late 1940's, overcrowding in the central area had spilled over into surrounding districts. Singapore had one of the world's worst slum problems. Squatter settlements sprang up around the city centre. Wealthy residents moved out of the city centre and built new homes in outlying districts. There was no low-cost public housing for poorer residents.

In 1960, the Singapore government set up the Housing and Development Board to provide low-cost public housing for people resettled from slum squatter housing in the central area of the city. The new homes were in high-rise estates, designed on the "neighbourhood" concept, like the new towns built in some European countries in the 1950's. Each neighbourhood housed from 1,000 to 5,000 families. Each of these estates had its own schools, markets, shops, and playgrounds. These estates were within about 30 minutes' commuting distance of the main employment zones within the central area of the city.

Singapore has continued to build high-rise public housing, at costs below the market price of private homes. The later new towns have better facilities. Flats are constructed to higher standards and with better materials. Estates are served by public transportation, through buses and the MRT (Mass Rapid Transit) rail system. Many estates have light industries close by. Almost 87 per cent of Singapore's citizens live in public housing estates or new towns, located in every part of the island.

Central Singapore was redeveloped as a commercial



Orchard Road is a beautiful street lined by fine buildings in the central Singapore business district.

centre as slums were cleared. The central area is known locally as the *Golden Shoe*. The port area, with its warehouses and docks, is nearby. The main shopping and hotel district is in a separate section. Tall office buildings, shopping complexes, and luxury apartments are found throughout the central area. Cultural activities such as drama, ballet, and concerts are held frequently within the city. The traditional *wayang* theatre is also popular (see *Wayang*).

Conservation. Singapore has designated older traditional areas and buildings as conservation sites. These sites are protected in some cases from redevelopment. The colonial heart of the city, including the Raffles Hotel,

Chinatown, Little India, and the Malay district known as the *Kampong Glam* has been preserved.

Recreation. With most of its population living in high-density high-rise housing, there is a big demand for open space for recreation in Singapore. The main recreational areas are along the northeast, east, and west coasts. All public housing estates have open spaces, sports facilities, and parks. There are small open spaces all over the city.

Industrial areas. Many major industries have moved to Jurong, a large industrial estate on the southwestern coast. There are smaller industrial estates, and research and office parks in suburban areas around Singapore.





Water pipelines from Malaysia carry water to Singapore.

Land

Most of the land of the islands of Singapore lies near sea level. The highest point, Bukit Timah Hill, is only 177 metres above sea level. Almost 50 per cent of the total land area is built upon. About 40 per cent is made up of open spaces such as parks, quarries, military bases, inland waters, and unused land. Only 2 per cent of Singapore's land area is given over to farming. Many local farmers are adopting high-technology methods, such as *hydroponics*—growing plants in chemical solutions without soil—to boost food production.

Igneous rock is found in the hilly central and north-central region. Sedimentary rocks are found in the west and south. There are sand and gravel deposits in the flatter eastern region. More recent layers of rocks lie over all three of these ancient rock types.

Plants and animals. Vegetation in Singapore has been altered by human settlement. Rainforests once covered most of the main island. But most of the forest was cut down as Singapore grew into a prosperous British trading settlement. Trees were removed first to make way for crops such as nutmeg, cloves, and pepper, and

gambier, a tropical plant used to make dye. Later, rubber and coconut plantations were established.

Large wild animals such as tigers, wild boar, mousedeer, and anteaters that used to roam Singapore's forests are no longer found. Small mammals include monkeys, squirrels, and civet cats. Birds and reptiles, including monitor lizards, pythons, and cobras, are also common.

Climate. Singapore is near the equator, and has a hot, moist climate. The average annual temperature is about 27° C. However, sea breezes cool the country so day temperatures seldom rise above 31° C. Rainfall averages about 2,400 millimetres a year. The monsoons control the seasons (see **Monsoon**). The wettest months are from November to March, when the northeast monsoon is blowing. The dry season is from June to October during the southeast monsoon. Thunderstorms are common in the months between the monsoons.

Although rainfall is plentiful, Singapore is not able to supply enough water to meet all its demands. The country buys water from the state of Johor in Malaysia to supplement stocks in its own reservoirs. Water supplies are tested daily.



Singapore is made up of one large island and 50 smaller ones. Most of the land lies near sea level. About half of the land area is built upon, but another 40 per cent is given over to open spaces such as parks.



Singapore's harbour, with its busy container port, dominates Singapore's economy. It handles goods or raw materials from most of the countries in the world, and operates both day and night.

Economy

Singapore has a highly developed economy. Before the 1960's, the country was essentially a trading nation. Since then, it has developed a more varied economy. It has become an important financial, trade, and transportation centre. Tourism is also important. The country's annual income *per capita* (per person) is one of the highest in Asia. The people of Singapore enjoy a high standard of living and welfare services. There is one doctor for every 837 people, and one government hospital bed for every 269 people.

Singapore has few natural resources. Its main resource is its people. Unemployment is low, about 2 per cent. About 28 per cent of employed people in Singapore work in manufacturing; about 23 per cent in commerce; 22 per cent in community, social, and personal services; and 10 per cent in transport, storage, and communications.

Trade. Since Singapore was founded as a trading station in the 1800's, its economy has been based on trade. It has a natural, deepwater harbour. It is situated in a strategic location on major trade routes between East and West. Singapore practises free trade. It is an *entrepot* port, serving as a centre for the import and re-export of goods. It is also a warehousing and distribution centre for the Asian and Pacific regions.

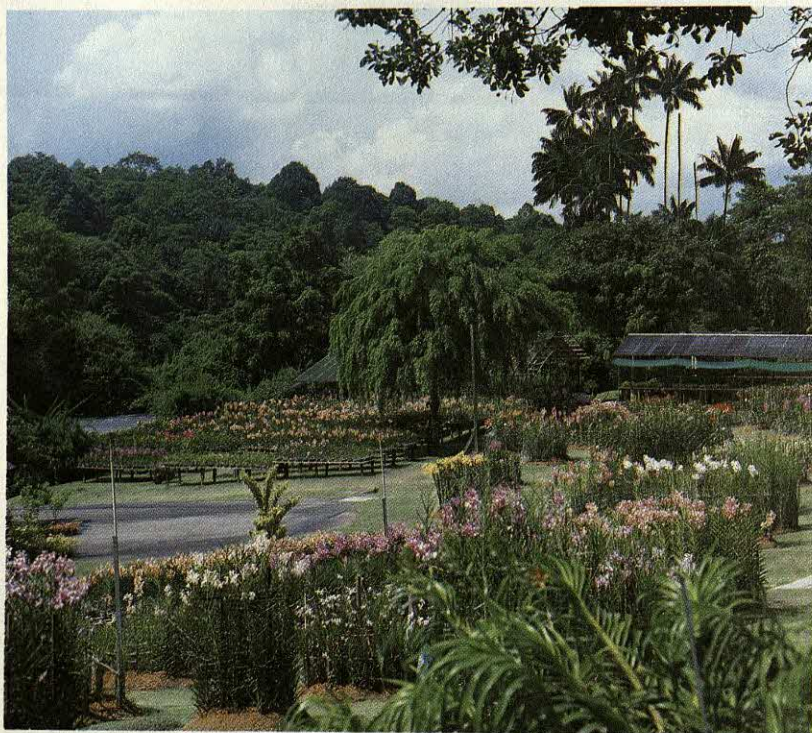
In terms of shipping tonnage, Singapore's port is the busiest in the world. Singapore's main trading partners are the European Union, Japan, Malaysia, and the United States. Singapore imports a wide range of goods, including electronic and electrical goods, foodstuffs, iron and steel, petroleum, plastics, and rubber. Singapore exports, or re-exports, clothing, electronic components, petroleum products, rubber, and telecommunications equipment.



Singapore's container port operates as fast at night as in the daytime. The Táijong Pagar Terminal can unload and load a ship in less than nine hours.



Container handling equipment is controlled by an advanced computerized handling system.



Orchids grow in a commercial nursery at Mandai. Singapore nurseries export orchids to Australia, Europe, Japan, and the United States.

Manufacturing. Singapore is also a major manufacturing centre. Its factories produce chemicals, clothing and textiles, electrical and electronic equipment, household appliances, machinery, optical and scientific apparatus, and rubber and plastic products. It is also a major centre for food processing, petroleum refining, and shipbuilding and repairing.

Since the early 1960's, industrialization has proceeded rapidly. Singapore set up the Economic Development Board in 1961 to promote industry as the key to economic growth. The Jurong industrial estate was opened in the western part of the island. It and some 20 other industrial estates are run by the Jurong Town Corporation, set up in 1968.

In the beginning, the industrial programme focused

on labour-intensive manufacturing to help solve unemployment problems in the early 1960's. After this programme succeeded, Singapore moved into higher-skill industries, and since the 1980's has concentrated on high-technology industries.

Agriculture has a minor role in Singapore's economy. Most farming is intensive, and uses the latest technology. Farmers produce poultry and eggs, and fruit and vegetables for the local market. Orchids are grown for export. Pig farming is being phased out because of the environmental damage caused by the waste from pig farms. Sea fish farming along the coastal waters of Singapore is increasing in importance. Aquarium fish are also produced for export.

Tourism is a major industry. About 5.5 million tour-



Electronic products, including many types of telecommunications equipment, are manufactured in Singapore.



Electrical products manufactured in Singapore form a major part of the country's exports.



Tiger Balm Gardens have long been popular with tourists, who admire the statues that depict Chinese myths and legends.

ists arrive in Singapore each year—more than the country's population. Tourists come mainly from Japan, Australia, Southeast Asia, the United Kingdom, and the United States. The Singapore Tourist Promotion Board was set up in 1964. The country has a wide range of hotels, with many major international hotel chains having branches there. Tourism is the country's third largest earner of foreign exchange.

Transportation and communication. Singapore's Mass Rapid Transit (MRT), which began working in 1987, offers a fast and efficient local railway service. Two lines cross the city centre linking 42 stations. The system spans nearly 70 kilometres and can handle up to 800,000 passengers a day. Buses also provide valuable transport for city workers. A causeway linking Singapore Island to the nearby tourist island of Sentosa opened in December 1992.

Singapore's roads are crowded because of the large number of cars. Drivers must pay a fee to enter the city during peak periods on weekdays. This system is called *the area licensing scheme* and has helped reduce traffic congestion at busy periods.

Singapore also has well developed transportation links with other countries. A railway links Singapore with Malaysia. Changi International Airport, at the eastern end of the island, is the nation's chief airport and one of the most modern airports in the world. About 50 airlines provide flights to more than 100 cities in over 50 countries around the world. Seletar Airport, which like Changi Airport is managed by the Civil Aviation Authority of Singapore, is used for charter and training flights.

There is one television set for every five people. The country has one telephone for every two people. It is an important telecommunications centre.

The Mass Rapid Transit (MRT) system has two lines and 42 stations, 15 of them underground. Each six-car electric train carries up to 1,800 passengers.





Sir Stamford Raffles, the founder of modern Singapore, is commemorated by a statue on the site of his 1819 landing on the bank of the Singapore River.

People have lived on what is now Singapore island since prehistoric times. From about the A.D. 100's to the 1200's, the present-day city of Singapore was known as *Temasek*, or *sea town*. The name *Singapore*, which means *lion city* in Sanskrit, has been used for the island and the city since the 1200's. The name was probably given because of the many tigers, mistakenly called lions, that inhabited the island. During the 1200's and 1300's, Singapore harbour served as a trading centre.

A Chinese trader, Wang Da Yuan, wrote an account of his visit to the island in 1349. He found a settlement of Malays and Chinese on terraced hillsides protected by a defensive wall. The wall protected the people from pirates and also from attacks by Javanese from the kingdom of Majapahit, which sought to control Temasek.

Early trading peoples from Melaka and Johor, both in Malaysia, used Temasek as a base. The Orang Laut, or "sea people," were a fishing group who lived in houseboats near river mouths on the island. In the 1300's, Temasek was destroyed by Majapahit forces (see *Majapahit*). Temasek then lost its importance as a trading centre and fell into obscurity.

In 1823, ancient ruins were recorded by the British official John Crawford. He described the ruins of buildings on *Bukit Larangan* (the Forbidden Hill), which was named Fort Canning Hill by the British. In 1928, gold ornaments dating from the 1300's or earlier were found. The so-called Singapore Stone, containing about 50 lines of undeciphered writing in the Kawi language, was

blown up in 1845 during building work, but a few fragments were saved. A piece is preserved in the National Museum of Singapore.

The arrival of Raffles. In 1819, Sir Stamford Raffles, an official of the British East India Company, arrived to set up a trading post. At this time, the Dutch controlled the trade routes with China and the East Indies. Raffles sought a base in the south of the Malay Peninsula, to attract trade and so break Dutch control.

Raffles and his assistant, Major William Farquhar, landed at Singapore on Jan. 29, 1819. They met the local Malay chief, Temenggong Abdul Rahman. This chief told them that the island belonged to the sultan of Johor, Tengku Abdul Rahman, who was under the control of the Dutch. Raffles decided to make another prince, the elder brother of Abdul Rahman, sultan in his place. This prince, Tengku Hussein, was the rightful heir to the throne. He travelled in secret to Singapore and was recognized as sultan of Johor by the British. A treaty was signed allowing the British to build a settlement on Singapore island.

Singapore was an instant success. It became a centre of free trade for the region. Traders from China, India, and Indonesia came to the new settlement. It became what Raffles had hoped for, the "emporium (market-place) of the East." Bugis traders from Celebes (Sulawesi, in Indonesia) collected goods such as spices, birds' nests, gold dust, elephants' tusks, rhinoceros' horns, and tin, and took them to Singapore once a year to *barter*



Mangrove swamps, which covered the banks of the Singapore River before settlement, now survive only in a few places.

(exchange) for manufactured goods. Chinese traders brought silk, tea, and porcelain from south China. Chinese traders also settled in Singapore.

The town plan. By 1821, the original small population of Malay, Chinese, and Orang Laut inhabitants had grown to 5,000. By 1824, the population had reached 11,000. Among the immigrants who settled in Singapore were Arabs, Armenians, Chinese, Europeans, Indians, and Malays. Chinese junks and large sailing ships from Europe began to call at Singapore. In the riverside settlement, the people lived in rough huts and houses, and there was much violence and disorder.

In 1822 Raffles returned for a third and last visit to Sin-



A Fragment of the Singapore Stone, an ancient monolith, is preserved in the National Museum.

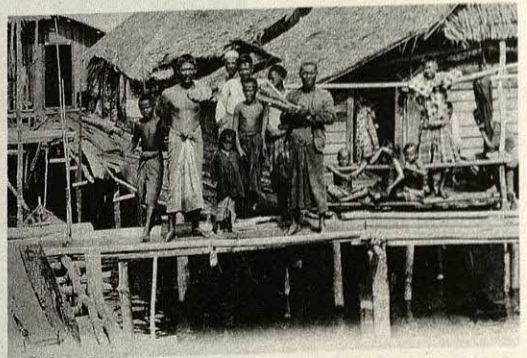
Important dates in Singapore

- 1819** Modern Singapore was founded by Sir Stamford Raffles.
- 1822** Raffles planned a new town.
- 1827** Serangoon Road is built—the first road across Singapore island.
- 1830** Straits Settlements, including Singapore, was put under control of British administration in Bengal, India.
- 1859** Fort Canning was built. The first ship repair dock was built by Captain William Cloughton.
- 1867** Straits Settlements became a British crown colony.
- 1869** The Suez Canal was opened. In the next ten years, Singapore's shipping trade increased by four times.
- 1877** William Pickering was appointed protector of the Chinese.
- 1914** Johor was the last Malay state to come under British control.
- 1923** A road causeway linked Singapore with Johor Bahru in the Malay states.
- 1942** The Japanese captured Singapore.
- 1946** Singapore became a separate crown colony.
- 1959** Singapore became self-governing, though Britain retained control of defence and foreign affairs.
- 1963** Singapore joined the Federation of Malaysia.
- 1965** Singapore became a fully independent member of the Commonwealth of Nations.
- 1971** The last UK troops left Singapore. Singapore joined a new defensive alliance with Australia, Malaysia, New Zealand, and the United Kingdom.

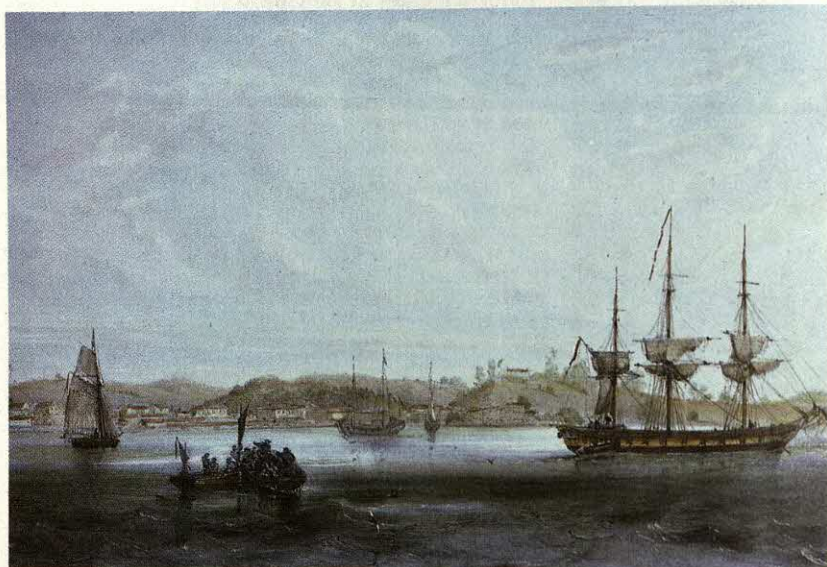
gapore. He drew up a town plan. Each community was given a *kampong*, or village section, of its own. There was a Chinese kampong, an Indian (Chulia) kampong, a Bugis kampong, a Malay kampong, and kampongs for all other communities. The European Town was close to the government area on the west bank of the river. The sultan had a palace in his own compound, with a mosque nearby. Each kampong had its own traditional trades. This historical division lives on in modern street names such as Bencoolen Street, Chulia Street, Carpenter Street, and Teochew Street.

Growth of trade. The old port on the Singapore River was soon too small for Singapore's booming trade. In the 1840's, the New Harbour, renamed Keppel Harbour in 1900, was established along the west coast.

Trade continued to grow and the importance of the port of Singapore increased after the opening of the Suez Canal in 1869. The canal shortened the sea voyage from London to Singapore from about 20,000 kilometres to about 12,000 kilometres. Steamships using the Suez



Traditional Malay houses are raised on stilts above the water and connected by wooden walkways.



Singapore in 1835 was visited by sailing ships, such as this *East Indiaman*, a merchant vessel of the British East India Company.

Canal could travel from London to Singapore in about 50 days. Singapore became the most important port in Southeast Asia for ships trading between Europe and Asia. New products such as tin and rubber from the Malayan mainland gave the port a further boost. Facilities at the New Harbour included dry docks, a coaling station, and warehouses.

The growth in trade and population prompted the British East India Company to acquire all rights to Singapore. In 1824, the *temenggong* (ruler) and the sultan signed away their sovereignty over the island to the British. Two years later, Singapore was united with Penang and Melaka to form the Presidency of the Straits Settlements. It was ruled from India. In 1867, Singapore became a British crown colony, ruled from London.

Piracy and crime. Singapore's trade attracted pirates from the Sulu archipelago and Mindanao, both in the Philippines. Some pirates even attacked ships in Singapore's port and then traded their loot openly in town. In 1832 and 1833, some Chinese merchants sent armed boats to patrol outside the harbour. In 1835, the British despatched two steamships to destroy the pirates. In the 1850's there were more attacks by pirates, this time from China.

Violence was also widespread in the town. The small police force could not deal with the problems of murder, theft, and Chinese secret societies. In the 1840's, a full-time police chief was appointed. By the late 1800's the police force had about 600 officers—still an inadequate number. The Chinese secret societies were a

European settlement expanded in the 1830's, as Singapore city grew rapidly. The British built a Protestant church, shown here in a print made in 1837.





The Padang in 1851 was a meeting place for Europeans. They walked, played games, or listened to the band.

source of lawlessness and riots until they were made illegal in 1890. However, they continued to be a menace until the outbreak of World War II in 1939.

Partly to deal with the Chinese secret societies, the British established the Chinese Protectorate in Singapore in 1877. William Pickering, the first British official to speak several Chinese dialects, was appointed the first Protector. He was able to persuade Chinese secret society leaders to accept him as a mediator in their disputes.

Treatment of immigrants. Pickering also tackled the ill-treatment of free-passage immigrants by the "coolie-agents." Poor immigrants from China would register with a coolie-agent in China for a free passage to Singapore. The coolie-agent and the junk captain would pack as many immigrants as they could into the small ship. Thousands of immigrants died during the voyages because of overcrowding, hunger, and thirst. The ill-treatment continued when the immigrants landed in Singapore. They lived in overcrowded lodging houses and were kept as prisoners until they were "bought" by employers. They had to work without pay for many months to pay off their passage, and were given only food and lodging. After the establishment of the Chinese Protectorate, officials controlled the coolie-trade.

Immigration from India was done by the indenture system. Immigrants were recruited by an agent in India. They were required to sign a contract to work for the same employers for five years for a fixed wage. Often they were paid low wages and worked in poor conditions.

A fairer "kangany" system came into use from the 1870's. A senior worker in Singapore was given money by his employer to recruit labourers from his village in India. This system did away with the abuses of the indenture system. Nevertheless, Indian nationalists complained that poor Indian villagers were never given a true picture of the hard work under harsh conditions that awaited them. The system declined during the slump in trade known as the Great Depression of 1929 to 1932, and was abolished in 1938. Indians continued to emigrate to Singapore. After World War II (1939-1945), Indian immigrants included merchants and professional people.

Malays did not migrate to Singapore in such large numbers as the Chinese or Indians. For this reason, they were soon outnumbered. The original Malay community was divided into followers of the temenggong and followers of the sultan. Each group was given a separate



Singapore waterfront in 1861 was the scene of great activity. Singapore had 82,000 people and was becoming busier.



The Singapore River in the early 1900's was crammed with small boats.

location. The Orang Laut people mixed with the Malay population. Immigrants in the 1800's came mainly from mainland Malaya, Sumatra, Java, the islands of Bawaen, Celebes, and Riau. Political unrest in the Malay Archipelago and the restrictive Dutch rule in Indonesia encouraged Malays to migrate to Singapore.

Immigrants' contributions. The immigrants of the 1800's went to Singapore with the aim of seeking their fortune and then returning home. The British made no provisions for the growing Asian population. Local community leaders set up religious buildings, schools, and hospitals. Narayana Pillay, a Hindu who had arrived with Raffles, established the first Sri Mariamman Temple in 1827. In 1844, a rich merchant, Tan Tock Seng, paid for the first pauper hospital to help the local people. Today it is a leading general hospital. Another merchant, Tan Kim Seng, gave funds to the government to bring fresh water to Chinatown. This was never done, so the money was used to construct a fountain bearing his name. The Melaka boat owner, Hajjah Fatimah, was the first woman to build a mosque. This Islamic place of worship, constructed in the 1840's, bears her name and still stands today.

Educational development. Raffles encouraged the construction of the first school, The Institution, in 1823. It was renamed Raffles Institution in 1868. Private philanthropists and missionaries set up schools for the various ethnic groups. Toward the end of the 1800's, the government established British and Malay schools. Chinese schools continued to be built and supported by the Chinese communities until the 1900's, when they were offered government grants.

At first, few parents thought it was necessary to educate their daughters. Nor was every boy sent to school. Poor parents kept their children at home to help them in their work. Later, wealthy people sent their children to British schools, so they could learn the English language. Chinese schools taught Chinese culture and traditions, and therefore were the choice of China-born parents. Very few Malay or Tamil schools were built.

The education system in colonial Singapore separated the different groups in the Asian population. The

British-educated people had better jobs and enjoyed a higher status in society. The rest, particularly the large numbers of Chinese-educated people, ended up as labourers or poorly paid teachers. This division of society had an impact on the politics of modern Singapore.

Economic development. Singapore's economy grew rapidly in the 1800's. The big business houses were dominated by Europeans with connections in Europe, China, and the Malay Archipelago. Among the well-known ones were the houses of Jardine and Guthrie. The Asian firms were not as big, but they played an important role as middlemen, buying from the Europeans and distributing goods to traders from China and the Malay Archipelago. Tan Kim Seng and Company was a leading Chinese business in the 1800's. There were also Indian, Arab, and Malay merchants.

The close economic links with mainland Malaya formed the mainstay of Singapore's flourishing trade. British rule had brought law and order to Malaya. Between 1874 and 1914, all the states in Malaya came under British rule.

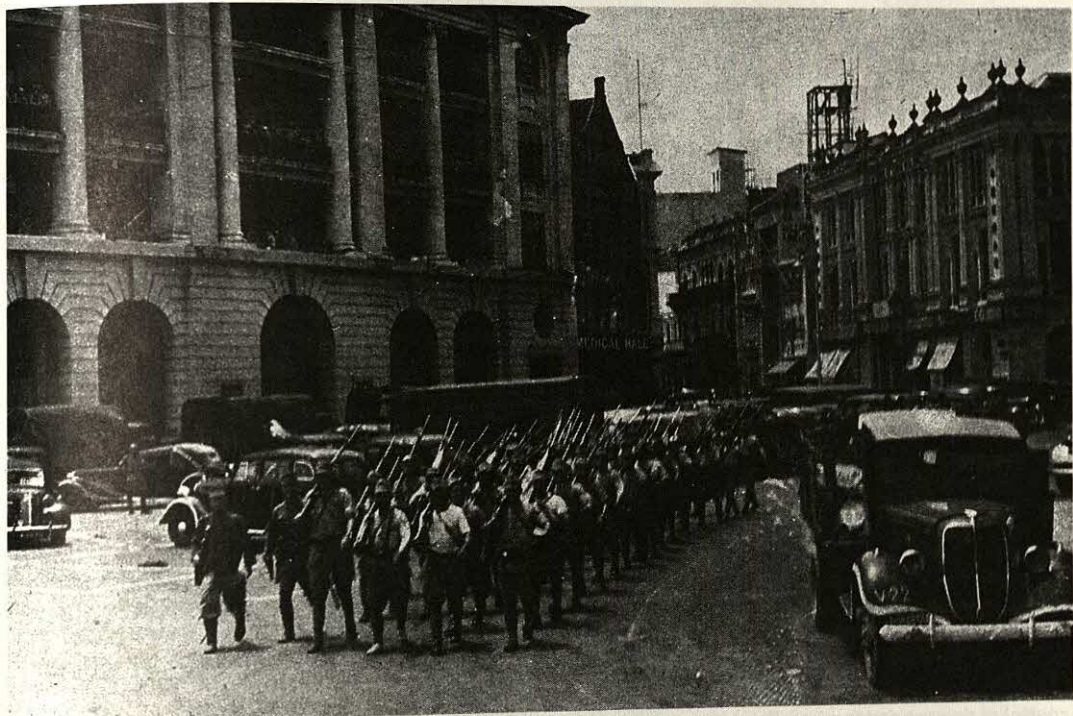
The tin and rubber industries of Malaya gave Singapore's economy a great boost. Tin smelting became Singapore's first industry. Tin ore was transported by rail and smelted at Pulau Brani, an island off Singapore. Tin ingots were exported from Singapore's port, and were one of Singapore's major exports. Another major export was sheet rubber. By the early 1900's, nearly 70 per cent of Malaya's foreign trade passed through Singapore.

By 1903, Singapore was the world's seventh largest port in tonnage of shipping. To modernize the port, the government took it over in 1905. Within the next ten years the Singapore Harbour Board had constructed two large docks, one of which was the second largest in the world. *Entrepot trade*, in which cargo was transferred from one ship to another within the port, continued to be Singapore's chief earner until the 1950's.

The 1920's and 1930's. As the economy continued to grow in the 1920's, an unprecedented number of immigrants entered Singapore. Most were from south China. This immigration trend was reversed when trade slumped during the economic depression of the 1930's.



Bullock carts were used in the early 1900's to carry goods handled by the growing port of Singapore.



Japanese troops marched through the streets of Singapore city, after their invasion and swift victory in 1942.

The government sent thousands of people back to India and south China, and reduced immigration numbers. Only women were allowed in without any restrictions. A unique group of single women came as labourers from Sam-Sui in Guangdong, south China. In their distinctive red headgear and navy blue *samfoo* (tunic and trousers) they could be seen on construction sites doing heavy manual labour. Other women worked as domestic servants. Most Indian women moved to mainland Malaya to work in the rubber estates.

New leaders emerged. The entrepreneur, Tan Kah Kee, stood out among the philanthropists. He helped found schools in Singapore. Lim Boon Keng, a doctor, led a Confucianist movement in Singapore and encouraged his fellow Chinese to learn and study their own language and culture. Mohammed Eunus, known as "the father of Malay journalism," used his pen to help politicize the Malays.

Most people still looked to their own homelands for political inspiration. In the 1930s, the Japanese invasion of China resulted in a boycott of Japanese goods in Singapore and the raising of money for an aid fund. Many young Chinese returned to China to fight the Japanese.

World War II and the Japanese occupation (1942-1945) had a great effect on the people of Singapore. The naval base, with its huge dry dock opened in 1938, was a symbol of British imperial power. But it was no defence against a land invasion. The British defenders of the island surrendered after 70 days. For Britain, the fall of Singapore was a catastrophe. The Japanese destroyed the myth of white superiority. In Singapore, they instituted a reign of terror and executed people who had

helped the Allies against the Japanese. Life was hard for everyone in Singapore, especially the Chinese.

Post-war political changes in India and China also affected Singapore. India became independent in 1947 and China became Communist in 1949. These changes forced Singaporeans of Indian and Chinese origin to look upon Singapore as their permanent home.

Toward independence. In 1946, Singapore was separated from Malaya and became a crown colony. The return of the British after the war did not bring immediate improvement. Food shortages and soaring inflation added to people's misery. Communists who had fought against the Japanese became more strident in their demands for workers' rights. Strikes were common. Chinese-educated people saw themselves as disadvantaged. Without speaking English, they could not join the civil service or the private sector. Higher education was not available to Chinese until Tan Lark Sye, a merchant, helped found a Chinese University. The Communists were very successful in recruiting students. Student sit-ins and boycotts of examinations, often involving clashes with the police, drew attention to their cause.

As the colonial government moved towards the introduction of democracy, political parties were formed. The British-educated people formed their own parties and sought to keep things as they were. They ignored the views of the Chinese-educated majority. The Chinese party fought for issues such as Chinese education and citizenship for those born in China.

Only one party in Singapore sought to bring the Chinese-educated people into mainstream politics. This was the People's Action Party (PAP). It was led by Lee



Lee Kuan Yew, seen here addressing banquet guests in London, led Singapore to independence and prosperity.

Kuan Yew, a lawyer, who joined the Communists to fight colonialism (see **Lee Kuan Yew**). In 1954, he was a founder of the People's Action Party (PAP). Singapore set up its first legislative assembly in 1955.

All political parties worked for independence within a union with Malaya. Malaya became independent in 1957. In 1959, Singapore became independent, with Lee Kuan Yew as prime minister. The United Kingdom retained control of defence and foreign affairs. Its economy depended on entrepot trade with Malaya, and few people believed Singapore could exist alone.

Malaya viewed Singapore's left-wing PAP with suspicion. Eventually, there was a break between Lee Kuan Yew and his Communist partners in the PAP, and the Communists grew in strength. This prompted Malaya's prime minister, Tunku Abdul Rahman, to announce the formation of Malaysia, a federation of Malaya, Singapore, Sabah, and Sarawak.

Federation. Malaysia came into being on Sept. 16, 1963. However, the union was not a happy one. The expected economic benefits did not materialize. Singapore's efforts to industrialize to solve its unemployment problems were hampered by the federal government's tight control. Relations worsened as Singapore's leaders tried to break into the Malaysian political arena, the preserve of Malays. Racial riots broke out in Singapore in 1964. When relations did not improve, the Malaysian prime minister asked Singapore to leave the federation. On Aug. 9, 1965, Singapore became independent.

Independence. When the first Singapore parliament met in December 1965, the opposition benches were empty. They had boycotted the opening, claiming that the independence was "spurious." Opposition members resigned their seats, and two fled Singapore to avoid arrest. There was no opposition in Singapore until 1981, when one opposition member was elected.

The new government of Singapore drew up ambitious plans for the survival of the new nation. Education was encouraged to forge a common national identity from Singapore's mixture of peoples. The school curriculum was geared to meet the needs of new manufacturing industries. National service was begun, and a new housing programme set up.

From the 1960's, industry began to replace the tradi-

tional entrepot trade as Singapore's chief income-earner. Health and social services were improved. In 1971 the last UK military forces were withdrawn from Singapore. Singapore's economy continued to grow. By the 1980's, it had become one of the most stable and prosperous nations in Asia.

In 1990, Lee Kuan Yew retired as prime minister. He was succeeded by the deputy prime minister Goh Chok Tong. Lee remained head of the People's Action Party and became a senior minister in Goh's Cabinet.

In 1993, Ong Teng Cheong became the first directly elected president of Singapore. He had previously held office as deputy prime minister.

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Questions

Why is Singapore important for world trade?
 Where did the ancestors of today's Singaporeans come from?
 What is a shophouse?
 How did Singapore get its name?
 Who were the Orang Laut?
 Why did Raffles choose Singapore as a trading post?
 Which army invaded Singapore during World War II?
 In what year did Singapore become independent from the Federation of Malaysia?

Singer, Isaac Bashevis (1904-1991), a Polish-born author, won the 1978 Nobel Prize for literature. Singer, who wrote in Yiddish, was the son of a rabbi. His Jewish education and Polish background formed the basis of his writing.

Singer was primarily a storyteller. His best-known tales are romantic or legendary rather than realistic. The narrators in some of his stories are imps or demons. Many of Singer's works combine modern realism with Jewish folklore and fantasy.

Singer grew up in a poor section of Warsaw. He described his life there in *A Day of Pleasure: Stories of a Boy Growing Up in Warsaw* (1969). Singer also wrote three other volumes of autobiography: *A Little Boy in Search of God* (1976), *A Young Man in Search of Love* (1978), and *Lost in America* (1981).

In 1935, Singer moved to the United States. Many of his works first appeared in the *Jewish Daily Forward*, a Yiddish newspaper published in New York City, and were later translated into English. Singer was best known for his short stories, collected in *Gimpel the Fool* (1957), *The Spinoza of Market Street* (1961), *Short Friday* (1964), *A Friend of Kafka* (1970), *A Crown of Feathers* (1973), *Old Love* (1979), *Stories for Children* (1984), *The Image* (1985), and *The Death of Methuselah* (1988).

Singer's novels include *Satan in Goray* (1935), *The Family Moskat* (1945), *The Magician of Lublin* (1960), *The Slave* (1962), *Enemies: A Love Story* (1972), *Shosha* (1978), and *The King of the Field* (1968). A work serialized between 1952 and 1955 was published as two novels, *The Manor* (1967) and *The Estate* (1969).

Singer, Isaac Merritt (1811-1875), more than any other person, made the sewing machine a universal household appliance. When a crude sewing machine was brought to him for repairs in 1851, his skill as a machinist led him to see how it could be made an efficient, versatile, and saleable device. Unaware of Walter Hunt's and Elias Howe's work on the sewing machine, Singer hit on solutions similar to theirs.

In 1854, the courts awarded basic patent rights to Howe. Then Singer organized sewing machine manufacturers into the first patent pool in American industry. The patent pool permitted seven leading companies to share the best features of the sewing machine.

By his energetic promotion and keen business sense, Singer acquired 13 million U.S. dollars. He was the first person to spend a million dollars a year on advertising. Singer was born in Oswego, New York.

See also *Sewing machine*.

Singh, Gobind (1666-1708), was the tenth and last *guru* (teacher of religion) of the Indian religious sect known as the Sikhs. For much of his life, he was persecuted by the Mughal emperor, Aurangzeb. In 1699, Gobind Singh formed the Khalsa. This was a military division of the Sikhs, open to all followers who wished to join it through baptism. A man who joins it adds the title *Singh* (lion) to his name. A woman adds *kaur* (princess) to her name. Members of the Khalsa must keep certain vows, such as promising never to smoke.

The most famous symbols of the Khalsa are the Five K's: *kes* (uncut hair), *kangha* (comb), *kirpan* (sword), *kara* (steel bracelet), and *kachh* (shorts). An orthodox male Sikh wears all these symbols, as well as his turban. Gobind Singh added his father's hymns to the *Adi Granth*, the Sikh holy book. His own hymns were separately collected in the *Dasam Granth* (Tenth Scripture).

See also *Adi Granth*; *Sikhism*.

Singh, Vishwanath Pratap (1931-), was prime minister of India from 1989 to 1990. He succeeded Rajiv

Gandhi. Singh won voter support with his stand against government corruption.

V. P. Singh, as he is known, was born in Allahabad during the British colonial period. His father was the *maharaja* (ruler) of a small state. When Singh was 5 years old, he was adopted by his father's cousin, another maharaja. In 1941, his adoptive father died, and Singh became maharaja. Singh continued as maharaja until India's independence in 1947, when the maharajas were peacefully deposed and their territories became part of the new country. Singh entered politics in the 1960's.



V. P. Singh

During the early 1980's, he was chief minister of Uttar Pradesh, India's most heavily populated state. From 1984 to 1987, he served as minister of finance and then minister of defence in Gandhi's cabinet. In 1987, he resigned, charging that Gandhi's government was corrupt. He formed the Janata Dal (People's Party).

In 1989, Singh's party ran against Gandhi's Congress Party, largely on an honesty-in-government platform. The Janata Dal alone did not win enough seats in Parliament to form a government. But it gained the necessary majority with the support of several other parties, and Singh became prime minister. However, in November 1990, Singh lost a vote of confidence in Parliament and was succeeded as prime minister by Chandra Shekhar of the Janata Dal (Socialist), a party formed by a split in the Janata Dal earlier that year. Following the elections of June 1991, the Congress Party formed a minority government. Singh's Janata Dal was the third largest party in Parliament. See *India, History of*.

Singing is the production of musical tones by the human voice with or without words. Singing is a natural form of expression found in cultures and societies throughout the world.

Singing may be accompanied by instrumental music, or it may be a *cappella* (without instrumental accompaniment). This article discusses how people sing, the major voice classifications, and voice training for the individual singer. For information on group singing, see *Classical music* (Choral music).

How people sing. Singing is produced in the same general way that a musical wind instrument creates sound—by causing a column of air to vibrate. A person sings by drawing air into the lungs and exhaling it past the *vocal cords*. The vocal cords are two folds of tissue that stretch across the *larynx* (voice box) in the throat. The movement of the air against the vocal cords and the surface of the throat and mouth causes vibrations that create the sound of the voice.

Because the vocal cords are elastic, the pitch of tones produced when the cords vibrate may be varied, depending on the degree of tension. The more tightly the vocal cords are stretched, the higher the pitch. The more relaxed the vocal cords, the lower the pitch. A man's vocal cords tend to be longer, wider, and thicker

than those of a woman. As a result, a man's voice tends to be an octave or more lower than a woman's voice.

Voice classification. Both men's and women's voices fall into three general categories of pitch—high, middle, and low. Within these categories, voices are classified into six basic types. From highest to lowest in pitch, they are *soprano*, *mezzo-soprano*, and *contralto* for women; and *tenor*, *baritone*, and *bass* for men. Most voices belong in the mezzo-soprano and baritone categories. See also *Opera*. (The singers).

Training the voice. Singing is a natural function and it requires no training to perform simple music. But serious singing makes special demands on the voice. Therefore, a singer requires special training to perform opera and other difficult music. Singers study and train to develop and improve four basic singing skills: (1) breath control, (2) a broad range, (3) smoothness throughout the range, and (4) good resonance.

Breath control allows a singer to perform long musical phrases in a single breath. The singer learns to breathe freely and naturally, filling the lungs from the bottom upward and expanding the chest cavity so that the lungs take in the maximum amount of air. The singer must learn how to release the air with evenly controlled pressure. The actions of muscles in the abdomen and chest cavities help the singer to achieve this goal.

A broad range allows a singer to correctly produce a wide span of notes from low to high. The singer's range determines his or her voice category. Training helps singers to produce the easy mid-range tones comfortably, and also the highest and lowest tones of which they are capable. Most untrained people can sing over a range of about 1½ octaves or less. But trained singers usually have a range of about two octaves.

Smoothness throughout the range means that a singer produces no audible breaks in the voice when moving from one tone to another. Some experts believe the voice is composed of either two or three *registers* (groups of tones within the range). They believe that the untrained singer whose voice breaks is moving from one register to another at the moment of the break. However, other experts believe that the entire range is composed of only one register, and that breaks result from other causes. All agree that the singer should be able to sing smoothly throughout the range, with no abrupt changes in the quality of the tone.

Good resonance strengthens and beautifies the tone. Resonance takes place as the tone vibrates in the cavities of the throat, mouth, chest, and face. Resonance occurs naturally and cannot be directly controlled by the singer. However, to allow this action to take place, the singer learns to open the throat by relaxing the throat muscles. The singer also learns how to relax the jaw and lips and where to properly place the tongue.

Other singing skills. Singers should learn to read music notation (the signs and symbols) and understand music terms. For example, where the term *mesa di voce* appears, the voice must increase the volume gradually from *pianissimo* (very soft) to *fortissimo* (very loud), and then back again. Singers also learn how to sing *trills*, which are quick alternations of two adjacent musical tones, and how to control *vibrato*, a vibrating sound made up of slight, rapid changes in pitch. Clear *diction* (speech) is important so the lyrics can be understood.

Related articles in World Book include:

Biographies

For biographies of opera and popular singers, see the *Related articles* at the end of the *Opera* and *Popular music* articles.

Other related articles

Barbershop quartet singing	Classical music	Minstrel Music	Oratorio
Bard	Country music	Musical comedy	Rock music
Blues	Folk music	National anthem	Song
Calypso	Hymn	Opera	Troubadour
Canon	Jazz	Operetta	Trouvère
Cantata	Larynx		Voice
	Mastersinger		
	Minnesinger		

Singsing is a Pidgin word used loosely to describe a dance, usually accompanied by group singing, in Papua New Guinea. It is a social occasion held to promote the idea of unity of the clan or group of people taking part.

A singsing is mostly related to the celebration of some event or activity or as part of the tribal ritual. It is also part of the principle of giving and receiving goods and assistance. This principle is basic in group life found throughout Papua New Guinea. Organizing a singsing is also one of the ways in which a man can gain status and influence in his society.

Singular. See *Number* (in grammar).

Sinkiang. See *Xinjiang*.

Sinn Féin is an Irish nationalist political party that played an important part in achieving an independent Irish republic. The Gaelic words mean *We Ourselves*. An Irish journalist, Arthur Griffith, formed Sinn Féin as an Irish nationalist society in 1905. Ireland was then part of Great Britain. Sinn Féin urged that the Irish refuse to pay taxes, to serve in the British Parliament or armed forces, or to abide by British court decisions.

In 1916, some Sinn Féin members took part in an uprising in Dublin during the Easter season. The British put down the rebellion, but this action added to Sinn Féin's popularity. In 1919, Sinn Féin members in the British Parliament met as an Irish national assembly, the *Dáil Éireann*. The assembly leaders were Arthur Griffith, Michael Collins, and Eamon de Valera.

In 1921, Great Britain and the Irish rebels signed a treaty establishing the Irish Free State in southern Ireland as a dominion within the British Commonwealth. In 1926, De Valera and a majority of Sinn Féin left the party because the party refused to recognize the new Irish government, whose members had to take an oath of allegiance to the British Crown. De Valera formed a new party, *Fianna Fáil* (Soldiers of Destiny). Sinn Féin lost much of its political influence. In 1932, *Fianna Fáil* won control of the government. The Irish Free State became an independent republic in 1949.

Today, Sinn Féin is the political wing of the Irish Republican Army (IRA), which has used violent action to seek Northern Ireland's freedom from British rule. Sinn Féin candidates run in elections in both Northern Ireland and the Republic of Ireland. But its victorious candidates in Northern Ireland have refused to take their seats in the British Parliament. In 1994, the IRA announced a complete cessation of violence, and peace talks were held between Sinn Féin and the British and Irish governments.

See also *De Valera, Eamon*; *Ireland, History of*.

Sino-Japanese wars. See Chinese-Japanese wars.

Sintering is the process of making metal parts from powdered metals. The powdered metals are pressed together in a die and are then heated in a furnace. The particles *sinter* (become bound) to each other, forming strong metal products. Sintering is used to make bearings, gears, and similar parts.

Sinus is a cavity in the bodies of animals, including human beings. When used alone, the term *sinus* generally refers to a hollow, air-filled space in the front of the skull. The human skull contains four groups of sinuses. Doctors sometimes call these groups the *paranasal* sinuses, because they all connect with the nasal cavity. Each group of sinuses takes its name from the bones of the skull in which it is found.

The *frontal* sinuses are in the frontal bone of the forehead just above the eyes. The *maxillary* sinuses, largest of the paranasal sinuses, are located in the cheekbones on each side of the nose. The *ethmoid* sinuses lie just above the nasal cavity, and the *sphenoid* sinuses are behind them. The sinuses lighten the skull, and make it easier to hold up the head and to balance it on the neck. They also cushion the brain from blows to the front of the skull.

The sinuses are lined with the same kind of membranes as those that line the nose (see **Membrane**). Infections of the nose spread easily to the sinuses. There,

Location of the sinuses Human beings have four pairs of sinuses. These cavities lighten the skull and make it easier to balance on the neck. Sinuses also provide drainage of mucus produced by sinus membranes.

Frontal
Sphenoid

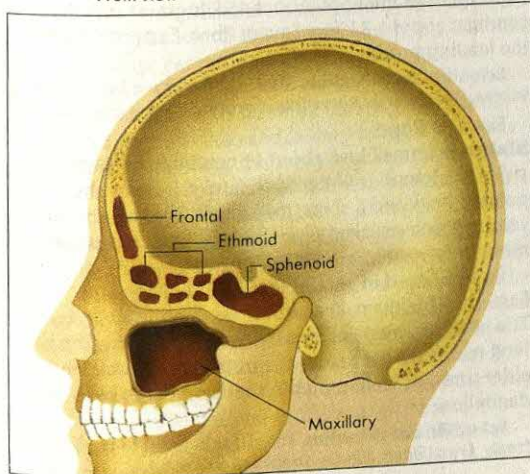
Ethmoid
Maxillary



Front view



Top view



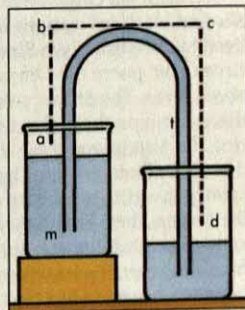
the infection causes a disease commonly called *sinus trouble*, or *sinusitis*. In sinusitis, the inflamed mucous membranes in the sinuses become swollen, closing the opening and preventing infected material from draining out. When this happens, painful pressure builds up in the sinuses. This pain may occur at the same time every day. Other symptoms of a sinus ailment may include dizziness and a running nose. Allergies, colds, influenza, and many other diseases often result in sinus symptoms. Other factors that may make certain individuals more susceptible to sinusitis include climate, dampness, drafts, and smoking.

The treatment of sinus trouble includes rest and liquid diet. Antibiotics and pain-relieving drugs are helpful. Sometimes surgery may be used to puncture a maxillary sinus and permit proper drainage, or to remove the abnormal sinus membrane. Sinus trouble is dangerous because it may serve as a centre of infection that spreads to other parts of the body, such as the eye or brain.

Sinuses occur only in mammals, birds, and crocodiles. The huge sphenoid sinus of the elephant extends to the very back of the skull.

See also **Cold**, **Common**; **Head**; **Hay fever**.

Siphon is a simple device for carrying a liquid from one level to a lower level. It consists of a hose or a tube bent so that one side is longer than the other. To begin working, the siphon must first be entirely filled with a liquid. If the short side of the siphon is then placed in a container of liquid, the liquid will flow up the short side of the tube and down and out the long side.



Siphon

The illustration with this article shows a siphon arrangement. The siphon works because of differences in pressure. The weight of the liquid in the long side of the siphon, *cd*, reduces the pressure in the tube, *t*. Atmospheric pressure on the surface of the liquid, *m*, then forces liquid up the short side of the siphon, *ab*. After the liquid reaches the top of the siphon, gravity pulls it down the long side of the tube and the siphoning action continues.

The siphon will work only until the liquid in both containers has reached the same level. Then, both sides of the siphon hold the same weight of liquid and the motion of the liquid stops. The siphon also stops working if its short side is pulled above the surface of the liquid. Air then rushes into the tube and the siphon empties without drawing any more liquid into it.

Siphonaptera. See **Insect** (table).

Siren is a device used to sound warning signals. Ambulances, fire engines, and police cars use sirens to alert traffic. Sirens called *foghorns* are used on lighthouses and ships to warn other ships away during foggy and other bad weather. Sirens are also used for air-raid warnings.

One type of siren has two cylinders, one inside the other. The cylinders are *perforated* (punched with

holes). This type of siren makes its sound when the outside cylinder revolves around the inner cylinder, and air is forced through the holes. An electric motor turns the cylinder in sirens on police cars, fire engines, and other vehicles. When the holes in the cylinders are lined up, puffs of air escape and cause vibrations. As the cylinder is turned faster, the puffs become more frequent and produce a wailing sound. Some sirens have perforated discs instead of cylinders, and some of these can be turned by hand.

A newer type of siren produces its wailing sound electronically. It has no moving parts, and it does not wear out as quickly as older types of sirens.

Sirenia is the name of an *order* (group) of water mammals related to elephants and hyraxes. The two living families are the dugongs and manatees (see **Dugong**; **Manatee**). The name *Sirenia* came from an old belief of sailors that dugongs and manatees were sirens or mermaids.

Sirenians live in the shallow waters along tropical seacoasts and in lagoons, swamps, and rivers. They feed on aquatic plants. Sirenians are regarded as threatened or endangered species worldwide. It is illegal to hunt them in most countries. Their low rate of reproduction makes it difficult for sirenian populations to grow.

See also **Sea cow**.

Sirens were sea nymphs in Greek mythology who lived on an island. Two Sirens are mentioned in the Greek epic poem the *Odyssey*. Most later authors wrote about three. The Sirens' sweet singing lured sailors to destruction on their island's rocky shores. In some stories, the Sirens would die if someone sailed past unmoved by their singing. The hero Odysseus (Ulysses in Latin) put wax in his sailors' ears so they could not hear the Sirens. Then he had them tie him to the mast. Odysseus could thus listen to the Sirens without endangering his ship. In art, Sirens were first portrayed as birds with women's heads and later as women with birds' legs and sometimes wings.

See also *Odyssey* (picture); **Capri**.

Sirex wasp is a large, metallic-blue wasp that attacks radiata pines and other cone-bearing trees in Tasmania and southeastern Australia. The female wasp drills a hole into the tree and lays an egg in it. A small grublike larva hatches from the egg and feeds on the wood. The wasps attack only dead or weakened trees. Parasitic insects that destroy the *Sirex* larvae have been imported in an attempt to reduce the pest populations.

Scientific classification. The *Sirex* wasp is in the *Siricidae* family. It is *Sirex noctilio*.

Sirius, also called the *Dog Star*, is the brightest star that can be seen from the earth at night. Sirius is about the same size as the sun, but it gives off nearly 30 times as much light. It is a star of the first *magnitude* (see **Star** [Measuring brightness]).

Sirius forms part of *Canis Major*, a constellation in the Southern Hemisphere. Sirius is one of the stars nearest the earth. It is about nine *light-years* away. A light-year, the distance light travels in a year, equals 9.46 trillion kilometres.

Astronomers classify Sirius as a *binary star* because it has a companion star, *Sirius B* (see **Binary star**). *Sirius B* is a *white dwarf*, an extremely dense star that can be as small as the earth. It consists of matter that is 4 million

times as dense as water. If matter from *Sirius B* were brought to the earth's surface, it would weigh approximately 4,000,000 metric tons per cubic metre. Because of its tremendous density, *Sirius B* exerts a strong gravitational pull on *Sirius*. This powerful gravitational force causes *Sirius* to move in a wavy line as it travels through space. *Sirius* and *Sirius B* make a complete orbit around each other about every 50 years.

See also **Calendar** (Ancient calendars); **Relativity**.

Sirius was the escorting vessel of the First Fleet, which took Governor Arthur Phillip with a company of marines and about 700 convicts from England to Australia to found the penal colony of New South Wales. The First Fleet arrived at Sydney Cove in Port Jackson on Jan. 26, 1788.

The *Sirius* left for Cape Town in October of that year to obtain provisions. It returned to Port Jackson in May 1789. Then it sailed to Norfolk Island, where it was wrecked on a reef. The anchor of the *Sirius* now stands in Macquarie Place in Sydney.

The *Sirius* was a ship of about 520 metric tons. It had a crew of 160 men. It was built to trade in the East Indies. In 1781, the British Admiralty bought it.

Sirocco is the Italian name for a warm wind that blows northward from the hot, dry Sahara or Arabian Desert. It occurs frequently during the spring in European countries on the north side of the Mediterranean Sea. A sirocco may pick up moisture as it crosses the Mediterranean and arrive at European shores as a warm, damp wind. As it moves north, it produces fog and rain. Some siroccos carry desert dust. When a dry sirocco blows, fine sand darkens the sky. The wind burns the skin and parches the throat. The term *sirocco* is sometimes applied to any unseasonably warm south winds in the Mediterranean region.

Sisal is the name for two tropical plants with swordlike leaves that yield a valuable fibre. These plants, *henequen* and *sisalana*, produce fibres 50 to 130 centimetres long, which are used chiefly to make binding twine. *Sisalana* produces much stronger fibre than henequen. Henequen is grown in Cuba, El Salvador, and Mexico, and *sisalana* in eastern Africa, Brazil, Haiti, and Java. *Sisal* is also called *sisal hemp*.

Sisal is harvested once or twice a year. The leaves are cut and fed into a *decorticator*, a machine that removes the pulp from the fibre. About 45 kilograms of leaves produce about 1-2 kilograms of fibre. Eastern Africa is the leading producer of *sisal*.

Scientific classification. *Sisal* is in the agave family, *Agavaceae*. Henequen is *Agave fourcroydes*. *Sisalana* is *A. sisalana*.

See also **Rope**.

Siskin is a small bird about 11 centimetres long. The siskin is a member of the finch family. It has a sharply pointed beak and a short, forked tail. The male siskin has yellow-green streaked plumage; the female is paler and more grey.

Siskins breed in conifer forests of Europe and the Far East. They build small, compact nests high up in trees. The nests are made of moss, lichens, and grass. Siskins feed mainly on the seeds of spruce, pine, birch, and alder trees, as well as on the seeds of plants such as dandelion.

Scientific classification. The siskin belongs to the finch family, *Fringillidae*. It is *Carduelis spinus*.

Sisley, Alfred (1839-1899), was an impressionist artist best known for his landscape paintings. Sisley captured a variety of moods in his landscapes, ranging from cheerfulness to melancholy. His best pictures are delicately painted and reveal a more spacious, airy feeling than those of his fellow impressionists. Sisley particularly excelled in portraying snowy and misty scenes. See **Impressionism** (picture).

Sisley was born in Paris of English parents. In the early 1860's, he studied in the Paris studio of the Swiss artist Charles Gleyre. There, he met the future impressionists Jean Frédéric Bazille, Claude Monet, and Pierre Auguste Renoir. Sisley's early pictures emphasized dark browns and greens. By 1870, he was using lighter colours and painting more spontaneously. He did his best work in the 1870's.

Sisters of Charity are members of several Roman Catholic religious communities of women. They are devoted to serving the poor, the sick, the aged, and the orphaned.

Saint Elizabeth Ann Seton founded the Daughters of Charity of St. Vincent de Paul in the United States in 1809. She chose this name because she was inspired by the Daughters of Charity in France, founded by Saint Vincent de Paul and Saint Louise de Marillac in 1603. As the community grew, and as other similar communities were formed, they became collectively known as the Sisters of Charity. Communities operate in Europe, the Far East, North America, and Latin America.

See also **Religious life** (table).

Sisters of Mercy are members of a Roman Catholic order of nuns. The main mission of the Sisters of Mercy is to care for the poor and sick—especially distressed women—and to educate the young. The order was founded in Dublin in 1827. Its founder and first mother superior was Catherine McAuley (Mother Mary Catherine).

Today, there are communities of these sisters in all parts of the world. Each convent was at first a separate foundation subject to the local bishop. But now many convents belong to a more centralized organization headed by a superior general.

Sistine Chapel is a famous chapel in the palace of the Vatican in Rome. It was erected by Pope Sixtus IV in 1473. The chief papal ceremonies take place in this chapel. The Sistine Chapel also is used by the cardinals for the voting by which they elect a new pope. Canonizations and other ceremonies are held in St. Peter's Church.

The Sistine Chapel is a simple building, 41 metres long by 13 metres wide, and 26 metres high. But it has on its walls and ceiling some of the greatest art ever produced in the Western world. Brilliant artists of the late 1400's decorated the walls with paintings that tell the stories of Moses and Christ. Each side wall has six frescoes. The artists included Botticelli, Piero di Cosimo, Bartolomeo della Gatta, Ghirlandajo, Perugino, Pintoricchio, Rosselli, and Signorelli. On the ceiling are Biblical stories painted by the great artist, Michelangelo, between 1508 and 1512. The stories tell the history of the creation of the world, the fall of humanity, and the flood. On the wall above the altar is *The Last Judgment*, a painting 18 metres high and 9 metres wide. Michelangelo worked on *The Last Judgment* between 1536 and

1541. All of the frescoes in the Sistine Chapel are being cleaned and restored.

For paintings in the chapel, see the pictures with the articles **Michelangelo**; **Painting** (The later Renaissance); **Religion**; **Roman Catholic Church**; **David**; **Isaiah, Book of**; and **Jeremiah, Book of**.

Sisulu is the family name of two prominent black political leaders of South Africa. They are Walter Sisulu (1912-) and his wife, Albertina Sisulu (1919-). Walter Max Ulyate Sisulu and Nontsikelelo Albertina Sisulu were both born in Transkei.

Walter Sisulu joined the African National Congress (ANC) in 1940 (see **African National Congress**). He was a founder member and treasurer of the ANC Youth League. In 1949, he became ANC secretary-general. He was banned from political activity in 1952 and imprisoned by the government eight times between 1954 and 1964. As a leader of the ANC military wing, *Umkhonto we Sizwe* (Spear of the Nation), he received a life sentence at the Rivonia trials in 1964 for revolutionary activities. He was released in 1989. Sisulu was elected deputy president of the ANC in July 1991.

Albertina Sisulu was also an active member of the ANC. She was banned from political activity between 1964 and 1982. In 1984, she was elected president of the Federation of South African Women.

Sisyphus was the founder of the city of Corinth in Greek mythology. He was a notorious trickster, who deceived even the gods.

Sisyphus once outwitted the god Thanatos (Death). Zeus, ruler of the gods, had sent Thanatos to punish Sisyphus for revealing one of Zeus's love affairs. Sisyphus managed to capture Thanatos and bind him in chains. No one died while Thanatos was bound. The god Ares freed Thanatos and gave him power over Sisyphus. Then Sisyphus told Merope, his wife, to bury him without the usual funeral rites. After he died and went to Hades, the land of the dead, Sisyphus begged to be allowed to return to earth to punish his wife for failing to give him a proper burial. After gaining his release, Sisyphus refused to return to Hades.

The god Hermes finally captured Sisyphus and placed him under the control of Hades, ruler of the land of the dead. Sisyphus was forced to roll a huge stone to the top of a hill. Each time Sisyphus was about to roll the stone over the summit, it pushed him back to the bottom of the hill.

Sitar is a stringed instrument that originated in India or Persia. It is used in the classical music of northern India, Pakistan, and Bangladesh. The sitar has a long, broad neck made of wood and a pear-shaped body made from a large gourd. It has 7 main strings, which the musician plucks with a wire pick worn on the right index finger. It also has 12 or more *sympathetic strings*. These strings vibrate when the main strings are played. Adjustable metal strips called *frets* are attached to the neck of the sitar. They serve as fingering guides for the left hand.

The sitar probably was developed in the A.D. 1200's. It reached its present form during the 1800's and 1900's. It serves chiefly as a solo instrument, usually accompanied by a drum called a *tabla* and a lute called a *tambura* that produces a *drone* (continuous pitch). A sitarist improvises within a certain melodic framework known as a *raga* and a metrical framework called a *tala*. The instru-



The sitar is a stringed instrument used primarily to play classical music of India called *ragas*. The Indian musician Ravi Shankar, above, ranks as the world's most famous sitarist.

ment has become more familiar in the West since the 1960's. The Beatles and other rock groups have used it in their music.

Sitting Bull (1834?-1890) was a famous medicine man and leader of the American Hunkpapa Sioux Indians. Many people think that he was the leader of the Indians at the battle of the Little Bighorn, in Montana, on June 25, 1876, in which Lieutenant Colonel George Custer died. Actually, Sitting Bull acted only as the leading medicine man in the preparations for the battle. The year before, he had received a vision that all his enemies would be delivered into his hands. In the spring of 1876, Sitting Bull led a sun dance at which he told the Indians to change their way of fighting. Instead of showing off to prove their bravery, they should fight to kill, or they would lose all their lands to the white people. This new tactic led to the annihilation of Custer and his soldiers.

After the battle of the Little Bighorn, Sitting Bull and his followers were driven into Canada. He returned to the United States in 1881. After two years in confinement at Fort Randall in South Dakota, he lived on the Standing Rock Reservation in that state. There, in 1890, he helped start the Ghost Dance. The government thought this was an attempt to renew the Indian wars, and sent Indian police officers to arrest Sitting Bull. In the process, he and his son were killed.

Sitting Bull was born in what is now South Dakota. As a boy, he was known as *Hunkesni*, which meant *Slow*. However, after show-



Sitting Bull

ing great bravery in a fight against the Crow Indians, he received the name *Sitting Bull*.

See also Custer, George A.; Indian wars (The Sioux wars).

Sitwell, Dame Edith

(1887-1964), was an English poet, critic, and biographer. She became one of the most controversial literary personalities of her time because of her experimental, often obscure, poetry and her eccentric life style. Sitwell was known for her striking clothing, which included spectacular robes, and enormous pieces of jewellery.



Dame Edith Sitwell

In her argumentative writings, Sitwell attacked the low level of taste she saw in English society. She criticized snobbish social attitudes with poetry that emphasized patterns of sound and imagery. For example, in *Gold Coast Customs* (1929), Sitwell employed the rhythms of African music to create a satiric comparison between a tribe of African cannibals and society in England during the 1920's. Sitwell expressed her deep religious feeling and her passionate response to the horrors of World War II (1939-1945) in such collections as *Street Songs* (1942). Sitwell also wrote biographies of English royalty and authors, a novel, and literary and music criticism. Her autobiography, *Taken Care Of*, was published in 1965, after her death.

Sitwell was born in Scarborough into an aristocratic family. In 1923, she created a sensation with her public reading of *Facade* (1922), a sequence of 21 poems set to music composed by Sir William Walton. Sitwell was made a Dame Commander of the Order of the British Empire in 1954.

Sitwell's younger brothers, Sir Osbert Sitwell and Sir Sacheverell Sitwell, also became well-known authors. Sir Osbert's most enduring work was probably his five-volume autobiography (1944-1950). Sir Sacheverell gained recognition for his travel books and for his studies of art and architecture.

Siva. See Shiva.

Six, Les. See Milhaud, Darius; Honegger, Arthur; Poulenc, Francis.

Six-Day War. See Israel (History).

Sixtus IV (1414-1484) was among the most notorious of the Renaissance popes. He was elected pope in 1471, and Italian politics dominated much of his reign. He was also a great patron of Renaissance learning and the arts.

Sixtus was born Francesco della Rovere in Celle Ligure, near Savona, Italy. He joined the Franciscan religious order and gained fame as a theologian. After his election, his spiritual concerns receded as he enriched family members with papal offices and named six nephews cardinals. Sixtus became involved in a family plot to assassinate Lorenzo de' Medici, the leader of Florence, and his brother Giuliano. Lorenzo was wounded and Giuliano was killed. A series of wars between the papacy and rival Italian powers followed.

Sixtus tried to transform Rome into a centre of Renaissance

sance culture. He provided the first permanent home for the Vatican Library; supported the studies of the Roman Academy; and built the Sistine Chapel, named after him, in the Vatican (see **Sistine Chapel**). Sixtus also began the urban transformation of Rome from a medieval to a Renaissance city.

Sixtus V (1520-1590) was elected pope of the Roman Catholic Church in 1585. Sixtus was responsible for an enduring reorganization of the papacy, creating a more centralized and efficient papal administration. He set the number of cardinals at 70 and organized them into 15 congregations responsible for all the church's spiritual and temporal (nonreligious) affairs.

Sixtus left a lasting imprint on Rome. He undertook an extensive construction programme, including aqueducts, the Lateran Palace, and the dome of St. Peter's Church. Sixtus built a network of broad, straight avenues that linked Rome's major basilicas. Soon after his election, he ruthlessly regained control of an area in central Italy called the Papal States. The pope accumulated a huge treasury surplus through increased tax revenues combined with his personal thrift and administrative skills.

Sixtus was born in Grottammare, Italy, near San Benedetto del Tronto. His name was Felice Peretti. He joined the Franciscan order at the age of 12 and gained fame as a travelling preacher. In 1566, he became vicar-general of the order. He was named a cardinal in 1570.

Skagerrak is an arm of the North Sea. The Skagerrak divides Norway and Sweden to the north, and separates them from Denmark on the south. The name is often spelled *Skager-Rak* or *Skagerrack*. The Skagerrak is about 209 kilometres long. It is important because it links the North Sea and the Kattegat. The two channels form the entrance into the Baltic Sea. Along the shores of Jutland, no good harbours for ships exist. This coast is lined with dangerous sand banks. But along Norway, 130 kilometres away, good harbours are plentiful. For location, see **Europe** (map).

Skald, the Icelandic word for poet, refers to the Scandinavian poets of the Middle Ages. From the 900's to the 1200's, most court poets in Scandinavia came from Iceland. Most skaldic poetry honoured the rulers whom the skalds served. Many of these poems, or parts of them, are preserved in the Icelandic *sagas* of the 1100's and 1200's. Skaldic poetry was very complex in form. It had regulated patterns of *alliteration* (linking words by repetition of their first sound) and *consonance* (a kind of rhyme between syllables containing different vowels but ending in the same consonant). Skaldic poetry also used a type of extended metaphor called a *kenning*.

See also **Edda**; **Saga**.

Skate is the name of a group of fish that have flattened bodies, very large *pectoral* (side) fins, and thin, whip-like tails. There is no scientific difference between skates and rays except that the term *skate* is used to describe some of the larger species (see **Ray**). The *common skate* of the eastern Atlantic Ocean grows up to 2.5 metres long. It is olive-grey or brown in colour and has blue-grey underparts. It is a deep-water species. The common skate preys on other fish that are *cartilaginous* (without bones), such as dogfish and rays, as well as crustaceans and molluscs. It is a valuable and popular food fish.

The *big skate* lives in the eastern Pacific Ocean. In Canada, it is a valuable source of food. A common Australian skate is the *Pommy skate*, found in southern Queensland. It gets its name because of its resemblance to the common skate of the Atlantic. (*Pommy* is Australian slang for an Englishman.)

Scientific classification. Skates belong to the family Rajidae. The common skate is *Raja batis*, the big skate is *R. binoculata*, and the Pommy skate is *R. australis*.

See also **Stingray** (with picture).

Skateboard is a small board mounted on four wheels and ridden in the sport of skateboarding. Skateboards are made of fibreglass, metal, plastic, or wood, with wheels of a strong plastic called *urethane*.

Skateboarding requires skilful balancing to control the board. Experienced skateboarders can perform such stunts as *endovers* and *wheelies*. Endovers are a series of 360-degree turns. Wheelies are performed by riding the board so that the front or rear wheels are off the pavement.

Skateboarding started in California, U.S.A., during the



Skateboard parks have specially designed rinks. Safety equipment include helmets and elbow and knee pads.

late 1950's. It developed from surfing, a water sport that involves similar skills, and became a popular form of recreation. Some cities in the United States have built parks for skateboarding, and many communities sponsor amateur tournaments. The sport became popular in Britain during the 1970's.

See also **Adolescent** (picture).

Skating. See **Ice skating**; **Roller skating**. **Skeet** is an American form of clay target shooting. As in trapshooting, the target is thrown into the air from a metal-sprung trap. Two target houses are located 38 metres apart. The targets spring from each house over the centre post between the two houses, and at different angles of flight so as to approximate closely the effect of shooting at winged game.

Seven shooting stations, corresponding to the half face of a clock, are located on a 19-metre radius. An-

other is in the centre of the circle, halfway between the two target houses. Shooters, using shotguns, fire from each station. Most targets are thrown as single shots, alternating from each house. But some targets spring out in pairs, one from each target house, at different levels. The shooter tries to bring both of the targets down. The name *skeet* comes from a Scandinavian form of the word *shoot*.

Skeleton is the flexible, bony framework of any vertebrate animal. It gives the body shape, protects vital organs, and provides a system of levers, operated by muscles, that enables the body to move. The skeleton houses *bone marrow*, the blood-forming tissues. It stores such elements as calcium and phosphorus and releases them to the blood. The skeleton also contains smaller amounts of the elements magnesium, potassium, and sodium.

The human skeleton

The human skeleton has about 206 separate bones. That is, a human being generally forms that many bones out of cartilage while developing to maturity. Sixty bones are in the hands and arms alone.

The human skeleton

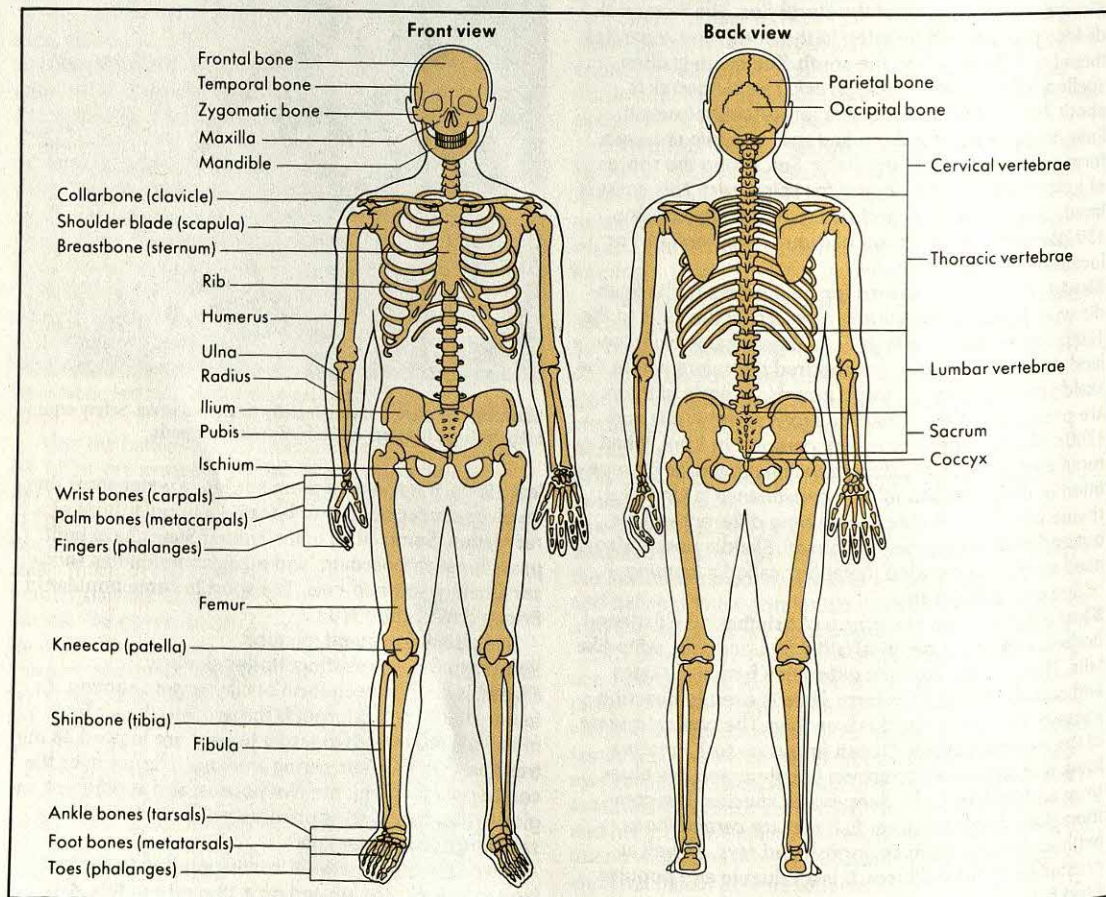
The skeleton is a strong, flexible framework that supports the body and protects the internal organs. It also provides a system of levers, operated by the muscles, that enables the body to move. The human skeleton consists of about 206 bones, some of which are *fused* (joined) in adults.

Bones are joined to neighbouring bones by joints. Joints are either immovable, as in the skull, or movable, as in the arms and legs. The bones fit together and are held in place by strong bands of flexible tissue called *ligaments*. The human skeleton is divided into two main parts, called the *axial skeleton* and the *appendicular skeleton*.

The **axial skeleton** is made up of the bones of the head, neck, and trunk. The spine (*spinal column* or *backbone*) forms an axis that supports the other parts of the body. The skull is at the top of the spine. The spine consists of separate bones, called *vertebrae*, with fibrous discs between them. Seven bones make up the *cervical vertebrae* (neck bones). The 12 *thoracic vertebrae* are at the back of the chest.

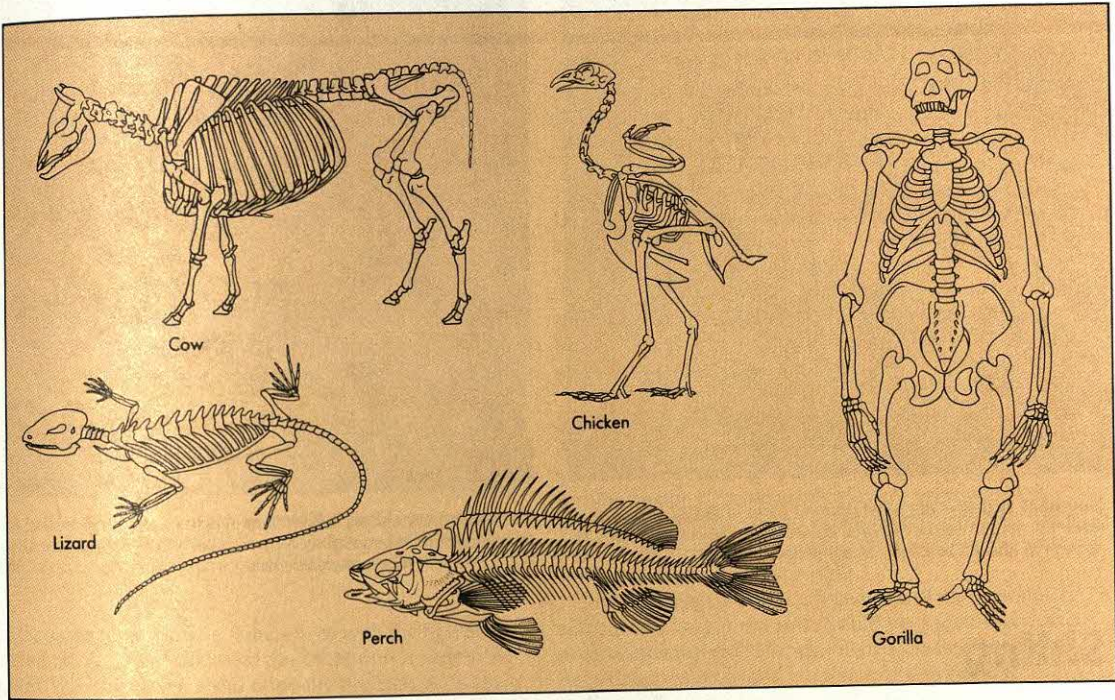
The ribs are attached to the thoracic vertebrae. There are usually 12 ribs on each side of the body. The upper ribs fasten in front to the *sternum* (breastbone). The ribs protect the heart and lungs, and act as a bellows box for the breathing process.

The five *lumbar vertebrae* lie in the lower part of the back. Below the last lumbar vertebra is the *sacrum*. In babies, five separate bones make up the sacrum. In



Some kinds of animal skeletons

All vertebrates share a basic skeletal pattern of an *axial skeleton* and an *appendicular skeleton*. The axial skeleton consists of the skull, the spinal column, and the ribs. The appendicular skeleton is made up of the bones of the appendages—arms, legs, wings, or fins—and their supports.



adults, these bones have grown together into one solid structure. The pelvis is attached to the sacral segment of the spine by *sacroiliac joints*. The coccyx is at the bottom of the spine. In children, four separate bones make up the coccyx. The three lowest of these bones often *fuse* (join together) during adulthood to form a beaklike bone. The point where the sacrum and coccyx meet remains fibrous throughout life.

The **appendicular skeleton** is made up of the bones of the arms and legs and their supports. The *shoulder girdle* consists of the *scapula* (shoulder blade) and the *clavicle* (collarbone). The skeleton of the arm is divided into the *humerus* (upper arm); *radius* and *ulna* (forearm); *carpus* (wrist bones); *metacarpus* (palm); and *phalanges* (fingers). The bones of the leg consist of the *femur* (thigh); *tibia* and *fibula* (leg); *tarsus* (back of the foot); *metatarsus* (forefoot); and *phalanges* (toes). The leg is attached to the trunk by a *pelvic girdle* made up of two hip bones. Each consists of three bones, the *ilium*, the *ischium*, and the *pubis*. These bones are fused in adults.

Animal skeletons

Most backboned animals have two pairs of limbs, front and hind limbs. A giraffe's neck has the same number of bones as a mouse's neck, although the giraffe's bones are longer and larger. Most mammals are *quadrupeds*. That is, they run on all four legs. Human beings are *bipeds* because they walk on only two legs. Many animals without backbones, such as insects and lobsters, have hard body coverings. This *exoskeleton* (external framework) provides both support and protection for the soft parts of their bodies.

Related articles. See the Trans-Vision pictures with **Human body**. For pictures of animal skeletons, see the specific articles, such as **Cat**. See also:

Arm	Hip	Shoulder
Bone	Joint	Skull
Collarbone	Leg	Spine
Foot	Pelvis	Vertebra
Hand	Rib	

Skelton, John (1460?-1529), was a great satirist during the early part of the reign of the House of Tudor in England. Skelton lived at court, and tutored Henry VIII, then a young prince. Skelton became a priest in 1498, and from 1502 served as rector of Diss in Norfolk. There he wrote *Ware the Hawk*, a savage satire on a priest who preferred hunting with falcons to religion; and *Philip Sparrow*, a playful elegy about a young girl's dead pet bird. His play *Magnificence* (1516) was a political satire. About 1520, Skelton wrote three poems that satirize the church and Cardinal Wolsey—*Colin Clout*, *Why Come Ye Not to Court?*, and *Speak, Parrot*. Skelton wrote much poetry in blocks of short, irregular, consecutively rhymed lines, a style that was later called *Skeltonic meter*. The place of Skelton's birth is not known, but he was probably born in Norfolk. He was educated at Cambridge University.

Sketching. See **Drawing**.

Skew line, in advanced geometry, is a line in space that neither runs parallel to another line nor intersects another line. The word *skew* means *slanting*, *indirect* or *distorted*.

In statistics, a normal distribution has a mound-shaped curve. A curve is called *skewed* if it tapers off to the right or left of a mound-shaped distribution curve.



Downhill skiing is the most popular form of skiing. Highly skilled downhill skiers can race down steep mountain slopes at speeds of about 100 kilometres per hour.

Skiing

Skiing is the act of gliding over snow on long, narrow runners called *skis*. Many skiers enjoy the thrill of speeding down mountain slopes. Others like the challenge of travelling long distances across flat or slightly hilly terrain. Skiing is an extremely popular form of entertainment in many countries. It is also a major competitive sport.

Types of skiing

There are three types of skiing: (1) Alpine skiing, (2) Nordic skiing, and (3) freestyle skiing. The two most popular and basic forms of skiing are *Alpine skiing* and *cross-country skiing*, a form of Nordic skiing. The following discussion describes the basic techniques of each type. For information on Alpine, Nordic, and freestyle competitions, see the section *Skiing as a sport*.

Alpine skiing refers to skiing downhill. It is popular as a form of recreation and as a competitive sport. The term *Alpine* comes from *Alps*, the name of the mountain system in Europe where downhill skiing originated.

Alpine skiing involves many techniques and manoeuvres. However, the three basic manoeuvres of downhill skiing are (1) schussing, (2) traversing, and (3) turning. Skiers carry a ski pole in each hand to help them keep their balance while making these manoeuvres. The poles also aid skiers in walking and climbing.

Schussing is skiing straight down a slope without turning or stopping. It is the fastest form of skiing because skiers follow the *fall line*—that is, the most direct route to the bottom of the slope.

Traversing is skiing at an angle to the fall line. Skiers use this manoeuvre to reduce their speed. They *edge* their skis while traversing to avoid slipping downhill



Cross-country skiing is hiking on skis over snow-covered ground that is flat or slightly hilly. This activity is easy to learn, but it requires much physical endurance.

sideways. Edging is done by tilting the skis at an angle to the slope so the metal edges of the skis bite into the snow.

Turning is the most difficult part of downhill skiing. Turning enables skiers to change direction, control their speed, and avoid obstacles. The most elementary turn is the *wedge*, or *snowplough*, in which the skis are placed in a V position with tips nearly touching and edged slightly inward. The wedge turn is also used to stop. A more complex turn is the *stem*. In this turn, the skis are first placed in a modified V position and are later brought to a parallel position. The *carved parallel* is the most advanced and difficult turn. In the carved parallel turn, the skier quickly turns both skis at virtually the same moment.

To halt their downhill progress, skiers make a sharp turn perpendicular to the hill and let the edges of the skis chatter across the snow. This manoeuvre is called a *hockey*, or *skate*, *stop* because it is similar to the way ice skaters stop.

Nordic skiing consists of (1) cross-country skiing and (2) ski jumping. The term *Nordic* refers to northern Europe—especially Norway, Sweden, and Finland—where cross-country skiing has long been a practical means of travel in winter.

Cross-country skiing is the most popular form of Nordic skiing, both as recreation and as a competitive sport. Cross-country skiers glide across snow-covered terrain that is flat or slightly hilly. The basic movement is the *diagonal stride*. This movement resembles jogging on skis. The skier leans slightly over the front of the skis and moves one ski forward, putting pressure on it to provide a platform for shifting weight onto the other ski



Ski jumping demands a high level of skill and concentration as well as strength, grace, and courage. In championship competition, ski jumpers may leap more than 90 metres.

as it comes forward. The manoeuvre with the first ski is called the *kick*, and that with the other one is called the *glide*. The pole in the hand opposite the kick ski is set in the snow and pushed backward to further propel the skier forward.

The *skate* is another movement in cross-country skiing. In the skate, one ski glides forward in a straight line, while the other is kicked out sideways and back in a skating motion to provide greater forward thrust.

To climb extremely steep hills, cross-country skiers often use a movement called a *herringbone*, the reverse of an Alpine skier's wedge. In a herringbone, the cross-country skier spreads the tips of the skis far apart and takes choppy little steps.

Ski jumping is a highly specialized form of skiing in which a skier slides down a steep track and flies off a platform at the end. Jumpers are evaluated on the distance of their leap and on the poise and grace they exhibit during the leap. Most ski jumping is performed on 70- or 90-metre hills. The measurements refer to the typical distance of a jump from the specially constructed hills. Any hill that permits jumps of longer than 90 metres is called a *ski flying* hill.

Freestyle skiing, also called *hot dog skiing*, is a form of skiing in which skiers perform stunts. There are three types of freestyle skiing: (1) aerial, (2) mogul or bump, and (3) ballet.

Aerial, the most dramatic type of freestyle skiing, resembles diving performed on skis. Aerial skiers ski down a steep hill and leap off a sharp platform, performing spins, flips, and other manoeuvres before landing. They are judged both on the difficulty of the stunt performed and on how well they execute it.

Mogul or bump freestyle skiing takes place on a steep slope with many *moguls* (moundlike elevations). Skiers try to ski quickly down a course while performing small jumps and acrobatic manoeuvres.

Ballet freestyle skiing combines movements used in figure skating and gymnastics. Skiing to music they select, competitors perform spins, pirouettes, rolls, somersaults, and other manoeuvres.

Ski equipment and clothing

Standard ski equipment consists of (1) skis, (2) ski poles, (3) ski boots, and (4) ski bindings. Skiers also wear certain clothing for warmth and comfort.

The equipment differs somewhat for Alpine and Nordic skiing and for recreational and competitive skiing. Using the proper equipment and maintaining it in top condition helps skiers perform better and also reduces the chance of injury.

Skis are narrow runners that curve up at the *tip* (front end). The centre part of the ski is called the *midbody*. The back end is called the *tail*. The midbody is raised above the tip and tail to make turning easier.

Skis can be made of a variety of materials, including fibreglass, plastic, metal, polyurethane foam, and wood. Alpine and freestyle skis are constructed in a similar way and have metal edges along both sides to make turning easier. Cross-country skis are narrower and lighter than Alpine skis and have no metal edges. Jumping skis are the longest and heaviest skis, usually measuring 240 centimetres in length.

In most cases, the taller, heavier, and more skilful a skier is, the longer the skis should be. Most Alpine skis are manufactured in France, Austria, Switzerland, and Italy. Cross-country skis are made in these countries, as well as in Norway, Sweden, and Finland.

Ski poles. All Alpine and most cross-country ski poles are made of aluminium alloys. They taper from the top to a point at the bottom. A ring or star-shaped piece of plastic called a *basket* is located about 8 centimetres from the point and prevents the pole from sinking too deeply into soft snow. Skiers hold each pole at the *grip*, a rubber or plastic handle at the top of the pole. The grip can be shaped like a sword handle or have a strap that fits around the skier's hand to prevent it from sliding down the pole. Poles for Alpine skiing should reach slightly above the skier's waist. Freestyle skiers use longer, thicker, and stronger poles because the pole must support the skier's weight during somersaults.

Cross-country poles resemble Alpine poles, but their

Terms used in skiing

Fall line is the most direct route to the bottom of a slope.

Mogul refers to a bump in the terrain. Most moguls are formed by many skiers turning in the same place and pushing the snow into a mound.

Parallel turn is a turn in which the skis are kept parallel and close together throughout the turn.

Schussing is skiing straight down the fall line without turning or stopping.

Short swing is a series of parallel turns.

Sitzmark is the impression made in the snow by a fallen skier.

Steered turn is a turn in which the skier uses pressure on only one ski to make the turn.

Stem is the initial movement in steered turns in which the back of the ski closer to the top of the slope is pushed out.

Traversing means skiing across a slope at an angle to the fall line.

Wedge, or snowplough, is a basic manoeuvre for slowing down or stopping. The back ends of the skis are pushed out, bringing the front ends together in a V formation.

Basic skiing techniques

A person must master certain basic techniques to become a skilled downhill or cross-country skier. The diagrams below illustrate some of the manoeuvres beginning skiers have to learn.

Downhill techniques

Schussing



Schussing is the fastest technique. The skier bends at the ankles, knees, and hips and follows the *fall line* (direct route down the slope).

Wedge or snowplough



The wedge, or snowplough, is the basic method of slowing or stopping. The tails of the skis are pushed out to bring the front tips together.

Traversing



Traversing is skiing at an angle to the fall line. The lower part of the skier's body is tilted toward the slope, so the skis' edges grip the snow.

Wedge, or snowplough turn



Carved parallel turn



Turns are the most difficult skiing manoeuvres. Skiers first learn the wedge, or snowplough, turn. It is begun in the wedge position and completed by putting weight on only one ski. To perform the carved parallel, skiers must shift their weight to turn both skis together.



Cross-country techniques

Diagonal stride



The diagonal stride is the basic movement in cross-country skiing. This diagram shows how the skier alternately moves one ski forward, while gliding on the other. As the ski moves forward, the skier brings the arm on the opposite side forward and plants the pole for speed and balance.

Skate stride

The skate stride enables the skier to pick up speed. The skier glides forward on one ski, while kicking out the other ski sideways and back in a skating motion. The skier plants both poles at the same time to help provide thrust.



point is set at an angle to the shaft. The point grips the snow when the pole is swung forward and slips out of the snow easily when the skier glides beyond the pole. Cross-country poles may be made of aluminium alloys, fibreglass, or such lightweight materials as boron or graphite.

Ski boots provide support and warmth for the skier's feet. Alpine boots consist of an outer *shell* made of rigid plastic and an *inner boot* made of a combination of foam, leather, or some other material.

Alpine boots come in two designs. *Overlap* boots are fastened by buckles across the instep and ankle. *Rear entry* boots have cables and plates, or air-filled bags inside the boot to secure the foot. These boots close with buckles around the rear of the calf. Freestyle skiers use Alpine boots.

Ski bindings are devices attached to skis to hold the boots firmly to the skis. If a skier falls, the bindings release the boot from the ski and thus help prevent injuries.

Alpine bindings secure the boot at both the toe and heel. They use a complex system of springs, cam rollers, and levers to ensure that skiers do not separate from their skis, except when injury might occur. Ski bindings also include *ski brakes*, which act by forcing two prongs into the snow when a skier releases a binding. The brake prevents a released ski from speeding down the slope and hitting other skiers.

Bindings on cross-country skis secure the boot only at the toe, keeping the heel free to lift during the kick phase of the diagonal stride. Many cross-country bindings also have a *ridge plate* behind the toe piece. The

ridge plate fits into a groove in the sole of the boot to keep the skier's foot from slipping off the ski.

Ski clothing is specially constructed to be extremely warm and waterproof. It should also fit snugly without restricting movement. Elasticized waist and cuff bands, snaps, and hook fasteners help keep snow from getting inside clothing. Most skiers dress in layers to create air pockets that trap heat. Alpine skiers generally wear warmer, heavier clothing than cross-country skiers because they produce less body heat while skiing. Alpine skiers normally wear thermal underwear, a turtleneck sweater, a parka, insulated ski pants, waterproof gloves, a hat, and one pair of medium weight socks. Cross-country skiers dress in similar clothing, but wear looser pants that allow greater movement. They also wear clothes that can be removed easily. Both Alpine and cross-country skiers wear goggles or sunglasses to protect their eyes from the sun's rays and to allow them to see better in stormy weather.

Skiing as recreation

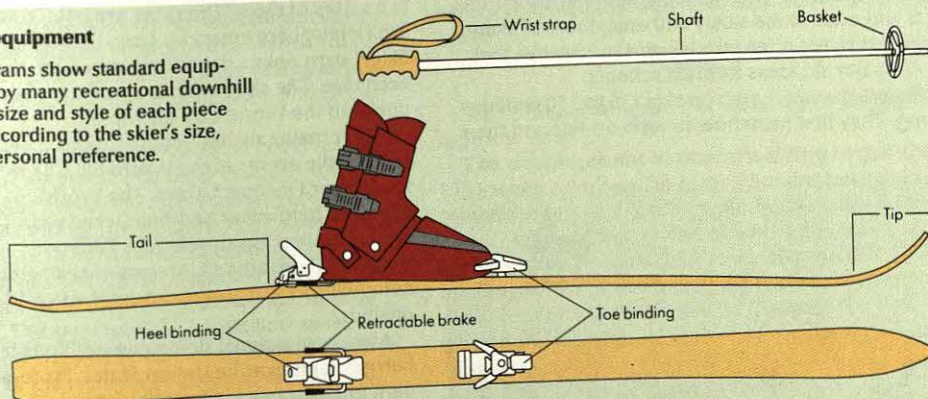
Skiing is an extremely popular form of recreation in many countries, especially in Europe and North America. It has also become an established sport in Argentina and Chile in South America, and in Japan, New Zealand, and Australia.

Ski area facilities. There are thousands of Alpine ski areas in the world. Most of these areas are in Europe, the United States, and Canada. Europe has some of the world's most luxurious and famous ski areas, including St. Moritz, Switzerland; Innsbruck, Austria; and Val d'Isère, France.

Ski equipment

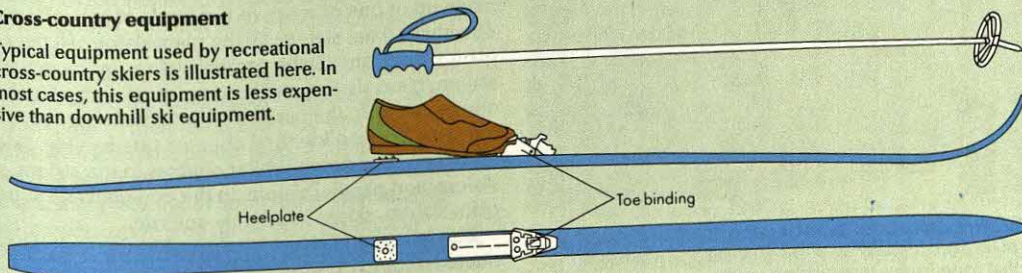
Downhill equipment

These diagrams show standard equipment used by many recreational downhill skiers. The size and style of each piece may vary according to the skier's size, skill, and personal preference.



Cross-country equipment

Typical equipment used by recreational cross-country skiers is illustrated here. In most cases, this equipment is less expensive than downhill ski equipment.



Most ski areas provide ski instruction and food and lodging services, and have shops that rent and sell ski equipment. Ski areas are usually located in hilly or mountainous regions with heavy snowfall. However, *snowmaking machines* make skiing possible in areas with light snowfall.

Many people enjoy cross-country skiing in parks, open fields, and other flat or somewhat hilly areas. In addition, many Alpine ski areas have paths for cross-country skiing called *touring centres*.

Ski trails range from smooth, wide, gentle slopes for beginners, to steep, narrow hills that challenge experts. Some trails, especially those in the United States, wander through wooded hillsides that require clearing before they become skiable. In Europe, many trails are located above the altitude at which trees stop growing. Using these trails, skiers are able to wander across vast areas.

Skiers should choose trails suited to their ability and should not ski alone. Many major ski areas hire professional *ski patrollers* to aid injured skiers and enforce ski safety rules.

All ski areas have *ski lifts*. These devices transport skiers to the top of a slope. They use a rope or braided metal cable attached to a motor-driven pulley to carry skiers uphill.

Snow conditions on trails vary greatly, depending on the weather, the ski area's location, and the time of year. Some areas generally receive light, dry snow called *powder*, which is ideal for skiing. *Corn snow* is tiny pebblelike snow that occurs most often in spring. *Packed powder* is the most common snow condition. It results from skiers repeatedly passing over freshly fallen snow, or from snow being compressed by tanklike *grooming machines*.

Ski instruction shortens the learning period for beginners and adds to the safety and enjoyment of skiing. Experienced skiers often take lessons to improve their skills. All major ski areas have ski schools.

Beginners generally start on skis 135 to 150 centimetres long. They first learn how to walk on skis and then



Beginners' ski classes in the European Alps usually start on gentle nursery slopes close to the village.

how to get up from a fall. Then they learn sidestepping uphill, traversing across a hill, schussing a short slope, and simple turns, such as the wedge. Later, they learn more difficult turns.

Skiing as a sport

The World Cup is the most important amateur skiing championship. World Cup titles are awarded each year to the man and woman who have won the most points in a series of races. The races are held in various Northern Hemisphere countries from December to March. Skiers earn points depending on where they finish in each race. The skier who accumulates the most points is declared the World Cup champion.

Other major amateur competitions include the Alpine and Nordic events of the World Ski Championships and the Winter Olympic Games. The World Ski Championships are held every odd-numbered year. The Olympics are held every fourth year. The Federation Internationale de Ski (FIS) governs all international amateur skiing competitions and also sponsors the World Ski Championships.

Most professional skiing competitions take place in Europe, Japan, or the United States. Professional skiers earn prize money for their finishes.

Alpine competitions. Most Alpine competitions are made up of one or more of five kinds of races: (1) the downhill; (2) the slalom; (3) the giant slalom; (4) the super giant slalom; and (5) the parallel slalom. In the downhill, slalom, giant slalom, and super giant slalom, skiers race one at a time. In the parallel slalom, two skiers race at the same time on identical courses side-by-side. Skiers make two runs down similar courses in the slalom, giant slalom, and parallel slalom. In the downhill and super giant slalom, skiers make only one run.

The following discussion describes the races as conducted under FIS regulations, which most amateur competitions follow.



Ski lifts carry skiers to the top of a slope. The chair lift, *above*, is a type of lift used at many ski areas. It consists of a series of chairs that hang from a motor-driven cable.

The downhill race is a test of high-speed skiing. It is run on a course with a vertical drop of 800 to 1,000 metres for men's events and 400 to 700 metres for women's. As a safety measure, *control gates* are placed along the course. They direct skiers away from dangerous areas and force them to reduce their speed. Each gate consists of two flags that the competitors must ski between. Skilled downhill racers average 95 to 105 kilometres per hour and can complete the course in 1½ to 2 minutes.

The slalom challenges skill in high-speed turning. The course is marked by numbered gates that each competitor must pass through in proper order. The gates are set so that the racers must make many turns, skiing in a zigzag fashion. The men's course has a vertical drop of 140 to 220 metres and 55 to 75 gates. The women's course drops 120 to 180 metres and has 45 to 60 gates. The gates are at intervals of 0.75 to 15 metres.

The giant slalom is a test of high-speed traversing. It combines elements of both the downhill race and the slalom. The men's course has a vertical drop of 250 to 400 metres. The women's course drops 250 to 350 metres. Both courses must have 30 or more gates set at least 5 metres apart.

The super giant slalom is a cross between the downhill race and the giant slalom. The men's course has a vertical drop of 500 to 650 metres and 35 to 65 gates. The women's course drops 350 to 500 metres and has 30 to 50 gates. The gates are placed at intervals of 15 to 25 metres.

The parallel slalom has two or more courses that resemble a small slalom course. The courses are from 6 to 7 metres apart. Both men's and women's courses have a vertical drop of 80 to 100 metres and 20 to 30 gates.

Combined competitions consist of a downhill race and a slalom. The two events are always held in the same location, but often take place on different days.

Nordic competitions consist of five events. They are (1) cross-country races, (2) cross-country relays, (3) jumping competitions, (4) the Nordic combined, and (5) the biathlon.

Cross-country races are conducted on courses that are about one-third uphill, one-third downhill, and one-third flat. In major meets, the men's courses are 15, 30, and 50 kilometres long. The women's courses are 5, 10, and 20 kilometres. In most races, skiers begin to race at 30-second intervals. But if a large number of skiers are participating in a race, they may start two at a time on parallel tracks. The skier with the fastest time wins.

Cross-country relays are team competitions in which each member of the team races an equal distance. For example, teams of four compete in the 40-kilometre men's relay in the Winter Olympics, and each member skis 10 kilometres. The first skiers from each team start at the same time.

Jumping competitions are popular spectator events in competitive skiing. Competitors receive points for both the length of their jump and their jumping style. The skier with the most points wins. A jumper may outdistance the other competitors but lose the event because of a shaky landing or some other flaw in style. Skilled jumpers often leap more than 90 metres.

The Nordic combined consists of both cross-country skiing and ski jumping. Competitors race over a 15-kilometre course and make three ski jumps. They re-



The giant slalom is a main event in most Alpine, or downhill, skiing competitions. Competitors traverse at high speeds and make sharp turns as they race through a series of gates.

ceive points for each activity, and the skier with the most points wins the event.

The biathlon combines cross-country racing and rifle-shooting. In most individual competitions, participants ski over a course 10 or 20 kilometres long on which targets are set at different points. The skiers must shoot at the targets from the standing and *prone* (lying down) positions and are penalized for every miss. The skier who completes the course in the shortest time wins. In the biathlon relay, four skiers each race 7.5 kilometres.

History

Skiing began thousands of years ago in northern Europe and Asia.

The development of modern skiing began about 1850, when a Norwegian named Sondre Norheim invented the first stiff bindings. Norheim made his bindings by tying twisted pieces of wet birch roots around his boots. As the roots dried, they became stiff. The bindings held the skis more securely than leather straps did and so provided the skier with greater control. With his improved bindings, Norheim developed new turning manoeuvres.

In 1896, Mathias Zdarsky of Austria introduced the technique of pushing one ski at an angle to the fall line to control speed. During the early 1900's, Hannes Schneider, who lived in the Arlberg region of Austria, developed new stopping and turning manoeuvres based on Zdarsky's technique. Schneider organized these manoeuvres into the first formal method of ski instruction. It became known as the *Arlberg* technique. This technique forms the basis of most modern skiing techniques.

During the early 1900's, skiing became an increasingly popular competitive sport. Switzerland held the first organized slalom race in 1921. In 1924, Nordic competitions were included in the first Winter Olympic

Games. The competitions now called the World Ski Championships began in 1925. In 1936, Alpine events became part of the Winter Olympics.

The invention of ski lifts during the early 1930's led more and more people to take up recreational skiing. In order to accommodate the increasing number of skiers, many ski areas and resorts were expanded or developed.

The mid-1900's. Early in World War II (1939-1945), Finland used ski patrols to resist Soviet invaders. In 1945, U.S. Army ski troops fought the Germans in the mountains of Italy.

After the war, skiing began a new boom. Winners of international competitions attracted increasing publicity. The big star of the 1950's was Toni Sailer of Austria—winner of three gold medals in the 1956 Olympics. The superstar of the 1960's was France's Jean-Claude Killy. He won the World Cup in 1967 and 1968 and three gold medals in the 1968 Olympics.

In recent years, the publicity that has been given to skiing champions and the coverage of ski competitions on television and in the press has stimulated interest in recreational skiing.

Related articles in *World Book* include:
Biathlon Switzerland (picture)
Olympic Games (The Winter Games; table) Water-skiing

Outline

I. Types of skiing

- A. Alpine skiing
- B. Nordic skiing
- C. Freestyle skiing

II. Ski equipment and clothing

- A. Skis
- B. Ski poles
- C. Ski boots
- D. Ski bindings
- E. Ski clothing

III. Skiing as recreation

- A. Ski area facilities
- B. Ski trails
- C. Ski instruction

IV. Skiing as a sport

- A. Alpine competitions
- B. Nordic competitions

V. History

Questions

- What are the three types of freestyle skiing?
- How does a skier avoid sliding sideways while traversing?
- What is the Nordic combined? The biathlon?
- What is a *herringbone*?
- What is the *fall line*?
- When are the World Ski Championships held?
- What is *corn snow*? *Powder*?
- Who was Hannes Schneider?
- Why is schussing the fastest form of skiing?
- Why do skiers wear sunglasses or goggles?

Skimmer, also called *scissorbill*, is a bird related to the gulls and terns. The name *skimmer* comes from its habit of skimming rapidly along the surface of the water. It holds its beak open and keeps the lower part of it beneath the surface, scooping up insects, small fish, shrimp, and other small animals. The name *scissorbill* comes from its thin, bladelike bill, which has the lower part much longer than the upper. The skimmer holds its body at an angle while flying, to keep its wings from touching the water.

Skimmers feed on the calm waters of lakes, and the edges of marshes. They often feed at dusk and at night.

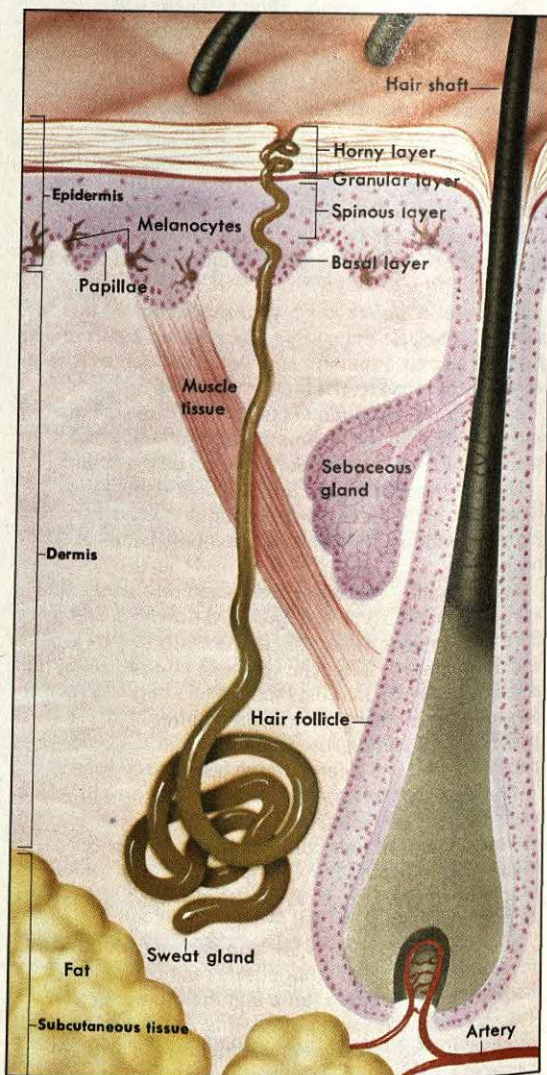
The pupil of the eye is a vertical slit like that of a cat which may help them see better in the dark. Skimmers are sociable birds. They nest on sandbanks in colonies of up to 1,000 individuals.

The *Indian skimmer* and the *black skimmer* of the Americas have orange-red bills. The *African skimmer* has a yellow-orange bill.

Scientific classification. Skimmers make up the skimmer family, Rynchopidae, genus *Rynchops*. The Indian skimmer is *Rynchops albigollis*, the black skimmer is *R. niger*, and the African skimmer is *R. flavirostris*.

See also *Bird* (picture: How birds feed).

Skin is the organ that covers the bodies of human beings and many other animals. In human beings, the skin protects the body in a wide variety of ways. For example, the skin is almost completely waterproof and so pre-



Human skin has three layers of tissue—the *epidermis*, *dermis*, and *subcutaneous tissue*. The epidermis consists of four layers of cells—*horny*, *granular*, *spinous*, and *basal*. The skin also has hair and two kinds of glands, *sebaceous* and *sweat*.

vents the escape of the fluids that bathe body tissues. It also prevents bacteria and chemicals from entering most parts of the body. The skin protects underlying tissues from harmful rays of the sun.

In addition, the skin helps keep the internal temperature of the body within normal levels. Glands in the skin release sweat when a person becomes overheated. The sweat evaporates and so cools the body. When a person becomes too cool, the body retains heat by narrowing the blood vessels in the skin. As a result, the flow of blood near the surface of the body decreases, and the body gives off less heat. The skin has many nerve endings that are sensitive to cold and heat, as well as pain, pressure, and touch.

The skin is the largest organ of the human body. If the skin of a 68-kilogram adult male were spread out flat, it would cover about 2 square metres.

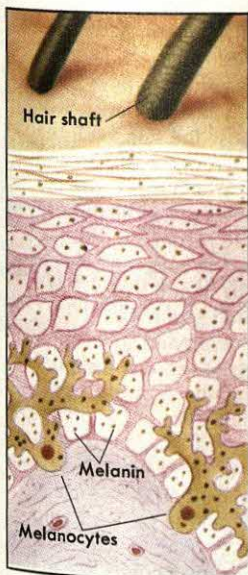
This article deals mainly with the skin of human beings. It discusses the structure and colour of the skin and various skin disorders. The last section describes the skin of other animals.

Structure of the skin

The skin has three layers of tissue: (1) epidermis, (2) dermis, and (3) subcutaneous tissue. The epidermis, the outermost layer, is about as thick as a sheet of paper over most parts of the body. The dermis, the middle layer, is between 15 and 40 times as thick as the epidermis. The subcutaneous tissue, the innermost layer, varies greatly in thickness among individuals. But in all people the subcutaneous tissue is much thicker than the epidermis and dermis. As well as these tissues, the skin includes the hair, nails, and certain kinds of glands.

Skin colour

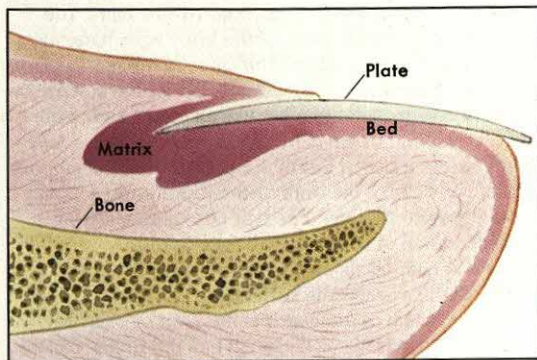
Skin colour depends mainly on the amount of brown pigment, called *melanin*, in the skin. In light skin, *below left*, cells known as *melanocytes* produce a small amount of melanin. In dark skin, *below right*, these cells produce more melanin.



Light skin



Dark skin



The nails of the fingers and toes are formed from certain cells of the skin. A nail has three parts—the *matrix*, *bed*, and *plate*. The matrix produces the cells of the bed and plate.

Epidermis has four layers of cells. From the outermost to the innermost, they are the *horny*, *granular*, *spinous*, and *basal layers*. The horny layer consists of between about 15 and 40 rows of dying cells. These cells are filled with a tough, waterproof protein called *keratin*. The granular layer consists of one or two rows of dying cells that contain small grains of a substance called *keratohyaline*. The spinous layer is composed of between about 4 and 10 rows of living cells that have spinelike projections where the cells touch one another. The basal layer is also made up of living cells. It consists mainly of a single row of tall, narrow *basal cells*. The basal layer also includes cells called *melanocytes*. These cells produce a brown pigment called *melanin*.

The basal cells divide continually and form *daughter cells*. Some daughter cells remain in the basal layer. Others move toward the outer surface of the skin and eventually form the upper layers of the epidermis. These cells are called *keratinocytes*, and they produce keratin. Keratin is found only in the epidermis, hair, and nails. Keratin makes the skin tough. It also prevents fluids and certain substances from passing through the skin. As the keratinocytes move upward through the epidermis, they become filled with more and more keratin. On reaching the surface of the skin, they have died and become flat and dry. Eventually, they are shed as thin flakes.

Dermis is made up chiefly of blood vessels, nerve endings, and connective tissue. The blood vessels nourish both the dermis and the epidermis. The surface of the dermis has many tiny elevations called *papillae* that fit into pits on the undersurface of the epidermis. They help connect the dermis to the epidermis. The papillae contain nerve endings that are sensitive to touch. The nerve endings are especially numerous on the palms and fingertips.

Subcutaneous tissue consists mainly of connective tissue, blood vessels, and cells that store fat. The subcutaneous tissue helps protect the body from blows and other kinds of injuries. It also helps retain body heat. The amount of fat in the subcutaneous tissue may increase after a person overeats. If the body needs extra food energy, it breaks down this stored fat.

Hair, nails, and glands. Hair, nails, and the glands in the skin are called *epidermal appendages*. They are formed from the basal cells of the epidermis.

Hair. Most of the skin is covered by tiny hairs. The scalp and some other parts of the body have large hairs. The palms of the hands and the soles of the feet have no hair at all. Part of each hair extends below the surface of the skin. This part lies in a baglike structure called the *follicle*. The end of the hair, called the *bulb*, is the only living part of a hair. It lies in the dermis or subcutaneous tissue. The cells of the bulb divide rapidly and account for the growth of a hair. The hair cells above the bulb contain a form of keratin called *hard keratin*.

Nails. A nail has three parts, the *matrix*, *plate*, and *bed*. The matrix lies under the surface of the skin at the base of the nail. Most of the matrix is covered by skin. But part of the matrix forms a whitish half moon that can be seen at the base of the nail. The plate is the hard outer part of the nail. It consists of many layers of flat, dead cells that contain keratin. The bed lies under the plate. The cells of the bed and plate are formed in the matrix. Newly formed cells push the older ones toward the tip of the nail. This pushing process results in the growth of the nail.

Glands. The skin has two kinds of glands, *sebaceous* and *sweat*. Sebaceous glands empty into hair follicles. These glands secrete an oil called *sebum*, which lubricates the hair and the surface of the skin.

There are two types of sweat glands, *eccrine* and *apocrine*. Eccrine glands produce the sweat that cools the body. They are located throughout the surface of the skin but are particularly numerous on the forehead, palms, and soles. Some eccrine glands produce secretions continually. Others become active only when a person is under physical or emotional stress. Eccrine glands release their secretions onto the surface of the skin. Apocrine glands produce sweat that has no important function. Most of these glands are in the armpits and around the *genitals* (external sex organs). They release their secretions into hair follicles.

Sweat is odourless until after it has been broken down by bacteria on the surface of the skin. After this process occurs, sweat has what many people consider an unpleasant odour. Apocrine sweat smells stronger than eccrine sweat, and so the armpits and genital area are the chief sources of body odour.

Skin colour

The colour of the skin varies greatly among races and individuals. Skin colour depends mainly on the amount of the brown pigment melanin produced in the skin. Melanin is formed by the melanocytes in the epidermis. All people have about the same number of melanocytes. However, the melanocytes of dark-skinned people produce more melanin than do those of light-skinned people. The amount of melanin produced in each person's skin is determined mainly by heredity. However, exposure to sunlight increases the production of melanin, causing light skin to tan. In some cases, melanin builds up in small spots, forming freckles. Most freckles appear on the face and hands. Exposure to sunlight may increase the number of freckles.

As someone grows older, the melanocytes produce melanin at uneven rates, which causes some areas of the skin to remain light and others to darken. These dark spots are sometimes called *age spots* or *liver spots*. As a person ages, the skin also becomes thinner and drier

and so starts to wrinkle and turn scaly. In addition, the skin of an old person bruises and chaps more easily and heals more slowly.

Skin disorders

Inflammation of the skin is called *dermatitis*. The most common form of dermatitis is *eczema*, in which the skin itches and becomes red. The skin may be crusty, or fluid may ooze from it. *Atopic eczema* is common in children. In most cases, it appears on the face, back of the neck or knees, or inner side of the arms. *Contact dermatitis* is an allergic reaction to certain substances that a person touches. For example, many people develop a rash after being stung by nettles.

Infections of the skin are caused by bacteria, fungi, parasites, or viruses. Some of these organisms invade the body in areas where the skin has been broken. Others remain on the surface of the skin.

Bacteria cause such infections as *boils* and *impetigo*. Boils are painful, red lumps filled with pus. Impetigo, which chiefly afflicts children, causes thin blisters to erupt on the skin. The blisters break, and the skin becomes crusty.

Fungi cause such infections as *ringworm* and *athlete's foot*. Ringworm is a general name for several kinds of fungal infections. Common ringworm is characterized by patches of red, scaly, ring-shaped spots. Athlete's foot is a type of ringworm in which cracks form in the skin between the toes.

Parasites that infect the skin include *lice* and *scabies mites*. Lice infest the hair of the scalp and of other parts of the body. Scabies mites burrow under the surface of the skin. Both lice and scabies mites cause the skin to itch and are contagious.

Viruses cause *cold sores*, *shingles*, and other kinds of infections. Cold sores are blisters that usually appear around the mouth. Shingles are painful blisters that occur primarily on the chest and lower back.

Burns may be caused by heat from fire or other sources or by chemicals, electric shock, or overexposure to sunlight. Doctors classify the injuries as *first-degree*, *second-degree*, and *third-degree* burns. First-degree burns cause the skin to turn red. These burns affect only the epidermis, and they heal without leaving scars. Second-degree burns cause the skin to blister. They affect the epidermis and part of the dermis and may leave slight scars. Third-degree burns cause the skin to blister or turn black. They damage all three layers of the skin. Some victims require surgery to remove dead tissue and repair the skin. The surgeon may perform a *skin graft*, in which the damaged tissue is replaced with healthy skin (see *Skin grafting*).

Sunburns may be mild or severe. Mild sunburn causes the skin to turn red, but the redness disappears in a few hours or days. Severe sunburn produces blistered skin and may be accompanied by chills, dizziness, and fever. Repeated sunburn over a long period may contribute to the development of skin cancer and excessive wrinkling. Sunburn can be avoided by the use of sunscreen lotions, which block out the sun's burning rays, or by gradual exposure to the sun, which results in suntan. Repeated suntanning also may contribute to the development of skin cancer and wrinkling.

Tumours are abnormal growths of cells. Tumours

may be *benign* or *malignant*. Benign tumours are non-cancerous and do not spread through the body. Malignant tumours are cancerous. In a process called *metastasis*, they can invade surrounding tissues or spread to distant parts of the body through the circulatory system.

Benign tumours of the skin include *lipomas*, *moles*, and *warts*. A lipoma is a large, soft lump of fat under the surface of the skin. A mole is a group of pigment cells that form a flat or raised spot on the skin. Most moles are black or brown. Warts, which are caused by a virus, may arise anywhere on the skin. Most warts are raised, rough, and dry, and they do not cause pain. However, *plantar warts*, which grow on the bottom of the feet, sometimes press against nerve endings in the dermis and so cause pain.

Malignant tumours of the skin include *basal cell epitheliomas*, *squamous cell carcinomas*, and *melanomas*. A basal cell epithelioma is the most common type of skin cancer. It begins as a small, pink lump that slowly enlarges. This type of skin cancer invades and destroys surrounding healthy tissue, but it does not metastasize. A squamous cell carcinoma starts as a thickening or a lump that later breaks down to form an ulcer with a crust. In some cases, this type of skin cancer metastasizes.

A melanoma is the most serious type of skin cancer. It often spreads from one part of the body to another by metastasis. A melanoma may start as a mole that itches or becomes sore, enlarges, grows crusty, and bleeds. A red area, brown spots, or a white ring may appear around the mole. Melanomas may be flat or raised and vary in size and colour. In most cases, skin cancer can be cured if the disorder is diagnosed and treated in its early stages. Although most skin growths are harmless, any unusual growths should be reported to a doctor immediately.

Other skin disorders include *acne*, *corns*, *hives*, *psoriasis*, and *vitaligo*. Acne most commonly afflicts teenagers. It consists of pimples, blackheads, and other blemishes, which appear mainly on the face, upper chest, and back. A corn is a painful thickening of the epidermis that occurs on the feet. Most corns result from pressure and friction caused by badly designed or poorly fitting shoes.

Hives are small, swollen, white or pink spots that itch. Many cases of hives are caused by allergic reactions to certain foods or medicines. Psoriasis is characterized by thick, raised, red patches of skin that are covered with silvery-white scales. Vitiligo consists of whitish patches of skin that have lost their pigment because melanocytes have been destroyed. Vitiligo is unpleasant because it affects appearance, but it is not painful or dangerous.

Animal skin

All animals with backbones have skin that consists of an epidermis and dermis. However, the skin of each species has different characteristics and is especially suited to the animal's environment.

Only the skin of mammals is covered by hair. Most species have long, thick hair that helps keep them warm. In many species, the hair colour blends with the surroundings and helps conceal the animal from enemies. Many animals have nails, claws, or hoofs, which help

them to obtain food and protect themselves. Claws are longer, sharper, and stronger than nails. Hoofs are larger than nails and claws, and consist of the same kind of cells that make up nails and claws.

Birds have thin skin covered with feathers. A feather grows in a kind of follicle that resembles a hair follicle. Birds shed their feathers at regular intervals throughout their lives. New feathers continually grow in the follicles and replace those that are shed. A bird has one large oil gland, which is located under its tail. The bird collects the oil from this gland in its beak and spreads it over its feathers. This process, called *preening*, makes the feathers waterproof.

Fish and amphibians have glands that secrete a slimy substance on their skin. The skin of many species of fish is covered by bony scales. Turtles have shells that consist of an inner layer of bone and an outer layer of skin tissues. Such reptiles as snakes and lizards have dry, scaly skin.

Related articles in *World Book* include:

Skin disorders

Acne	Elephantiasis	Pimple
Athlete's foot	Epithelioma	Prickly heat
Bedsore	Erysipelas	Psoriasis
Birthmark	Erythema	Ringworm
Boil	Hives	Scabies
Burns and scalds	Impetigo	Shingles
Callus	Leprosy	Sunburn
Corn	Lupus	Tumour
Dermatitis	Mole	Wart
Eczema	Neurofibromatosis	Wen

Other related articles

Dermatology	Perspiration
Epithelium	Pore
Gland	Races, Human
Hair	Scar
Nail	

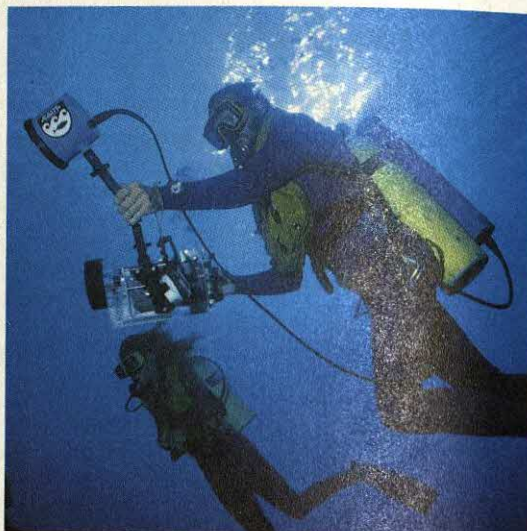
Skin disease. See *Dermatology*; *Skin*.

Skin diving is the act of going underwater while holding the breath or while breathing from tanks of compressed air. The term generally refers to *breath-hold diving*, the oldest and simplest form of underwater diving. Diving with the aid of air tanks is called *scuba diving*.

Both kinds of skin diving are popular forms of recreation among people of all ages. Many people enjoy exploring the beautiful world beneath the surface of rivers, lakes, and oceans. Recreational divers take underwater photographs, capture tropical fish, and collect shells and other objects.

Professional and military scuba divers perform important tasks underwater. For example, they repair ships, recover valuable objects, and help build and repair structures. Scientists use scuba equipment in the study of underwater biology and geology.

Many skin divers use such equipment as bags made of netting or canvas, knives, and underwater torches. Small fish can be captured with nets and suction guns, and harpoons or spear guns are used to kill fish for food. Divers take underwater photographs with waterproof cameras or with cameras enclosed tightly in waterproof cases. Professional scuba divers may communicate underwater with special electronic devices. Recreational divers communicate with simple hand signals.



Skin diving is a popular way to explore the fascinating world beneath the surface of rivers, lakes, and oceans. Most *breath-hold* divers, *left*, breathe through a short tube called a *snorkel*. *Scuba* divers, *right*, breathe from metal tanks of compressed air that are strapped to their backs.

Kinds of skin diving

Breath-hold diving requires no equipment, but most skin divers wear a face mask, flippers, and a short breathing tube called a *snorkel*. The face mask permits clear vision underwater. It consists of a plastic frame and a glass plate in a neoprene or silicone *skirt*. The skirt allows the mask to fit snugly over the face. The neoprene or silicone flippers help a person swim with greater ease. The diver breathes through the snorkel while floating or swimming face down on the surface of the water.

A breath-hold diver may wear a *wet suit*, a close-fitting coverall made of a material similar to foam rubber, to keep warm in cold water. Some water enters between the suit and the skin. But the diver's body heat warms this water, and the insulating properties of the suit holds in the warmth.

Breath-hold divers may also wear a weighted belt and a *buoyancy compensator*. The weight of the belt helps the diver stay at the desired depth instead of floating upward. The buoyancy compensator, which floats when in-

flated, also helps the diver maintain the desired depth and serves as a support if the diver becomes tired and wants to rest on the surface.

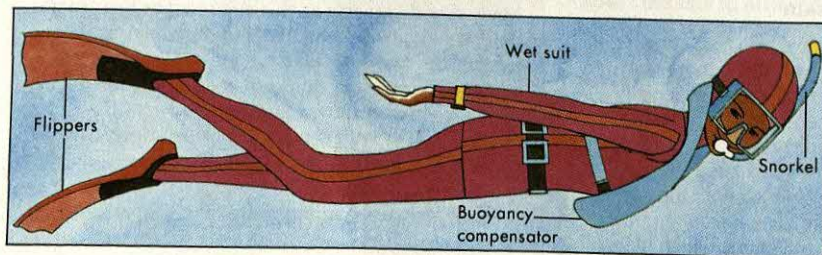
Breath-hold divers cannot descend deeply because they must continually return to the surface to breathe. Most divers can go 9 to 12 metres deep and must surface after less than a minute. Some can dive as far as 30 metres and remain submerged for about two minutes. Breath-hold divers can safely increase their time under water by remaining relaxed and swimming slowly so their demand for air is reduced.

Some divers take two or three deep, rapid breaths before diving. This process, called *hyperventilation*, enables a person to stay submerged longer. But excessive hyperventilation can be dangerous because it may cause divers to misjudge their air supply and pass out under water. This type of accident is called *shallow water blackout*.

Scuba diving involves the use of portable metal tanks of compressed air. The diver breathes from the tanks, and can remain under water for many minutes. A diver using one tank can stay at a depth of 12 metres for

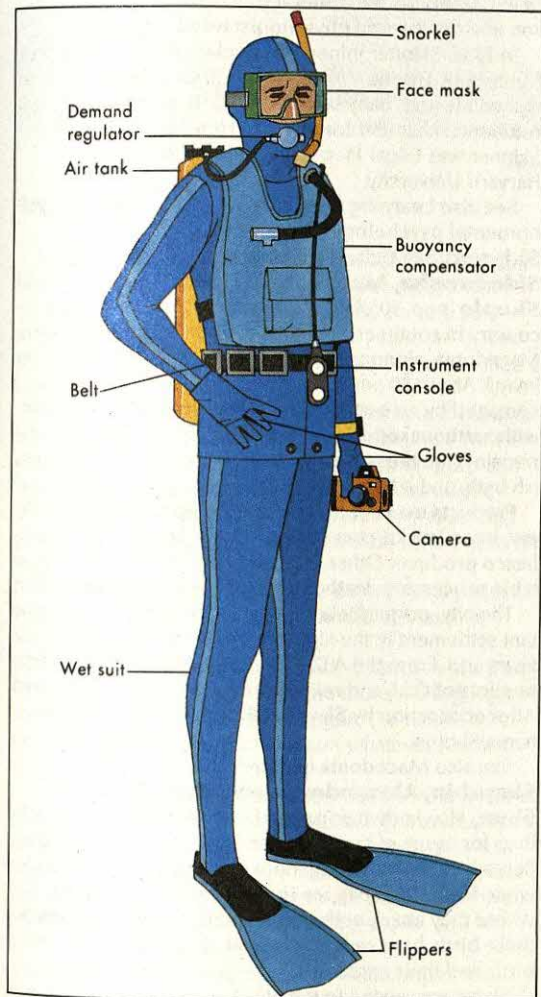
Breath-hold diving equipment

Most breath-hold divers use a face mask and flippers in addition to a snorkel. The mask provides clear vision underwater, and the flippers help divers swim with less effort.



Scuba-diving equipment

Scuba divers carry tanks of compressed air. The demand regulator controls the flow of air. The buoyancy compensator can be inflated if the diver wants to return to the surface quickly.



about an hour. Strenuous activity or an increase in depth uses up a diver's air supply more rapidly. The word *scuba* stands for self-contained underwater breathing apparatus.

Scuba gear consists of one or more tanks strapped to the diver's back, plus an air hose and a device called a *demand regulator*. The demand regulator controls the flow of air so that the air pressure within the diver's lungs equals the pressure of the water. The pressure under water is greater than on land, and it increases with depth. Serious injury can result if the pressure of the air in a diver's lungs does not equal the water pressure (see **Diving, Underwater** [Dangers of underwater diving]).

Scuba divers wear a face mask, a wet suit, a weighted belt, and flippers, and they use a snorkel and a buoyancy compensator. The diver breathes through the snorkel while swimming on the surface of the water and thus conserves the air in the tanks. The buoyancy com-

pensator may be inflated under water to help the diver maintain the desired depth, to change depths, and to rest on the surface.

Learning to dive

Beginner breath-hold divers and scuba divers should take lessons from an instructor who has been certified by a qualified organization. Beginners not only learn various skills, but also the dangers of diving and how to handle them.

A trained scuba diver with relatively little experience should not go deeper than 18 metres. An experienced scuba diver may safely dive about 40 metres. Recreational divers should not go deeper than 40 metres unless they have had advanced training and have made many supervised dives.

History

For thousands of years, people have dived under water in search of food and to gather pearls, shells, and sponges. Early divers used no equipment. Divers probably began using snorkels made of hollow reeds about the A.D. 100's. By 1300, Persian divers were using goggles that were made from the polished shells of tortoises.

Independent breathing devices for diving were first tested during the late 1800's and early 1900's. In the 1930's, divers began to use rubber goggles with glass lenses, and also face masks. Two Frenchmen, Jacques-Yves Cousteau and Émile Gagnan, developed the *aqualung*, one of the first breathing devices with a demand regulator. Cousteau tested the aqualung successfully in 1943.

See also **Diving, Underwater; Spearfishing.**

Skin grafting is a surgical method of replacing skin to cover wounds on the body's surface. Skin grafts are especially useful in healing severe burns. Loss of skin due to serious accidents, disease, or surgery may also require skin grafting.

Most skin grafts involve taking healthy skin from one part of a patient's body to cover a wound on another part of the body. This type of skin graft is called an *autograft*. The grafted skin may be either *full thickness* or *partial thickness*. A full thickness graft includes all the *epidermis* (top layer of skin) and the *dermis* (layer of blood vessels, nerve endings, and connective tissue). A partial thickness graft uses all of the epidermis but only a little of the dermis.

The part of the body from which the skin graft has been taken is called the *donor site*. If a partial thickness skin graft has been removed, the donor site heals in several days, much like a "skinned" knee or ordinary scrape. When a full thickness graft is removed, the donor site must be closed surgically.

The final result of a skin graft does not feel or appear exactly like normal, uninjured skin. After several years, however, the differences are usually slight.

Some patients do not have enough undamaged skin to provide autografts for the entire wound. In such cases, surgeons may cover some of the wound with temporary skin grafts. These grafts help prevent infections and fluid loss, but the body eventually rejects the covering. Many temporary grafts use skin from another person. Such grafts are called *homografts* or *allografts*.

Other temporary grafts, known as *heterografts* or *xenografts*, use specially prepared skin from pigs or other animals. Surgeons replace temporary grafts with autografts after the patient's body has produced new skin at earlier donor sites. Researchers have also developed "artificial skins" that are unlikely to be rejected by the body and can serve as temporary grafts.

In the mid-1980's, surgeons began using large sheets of "test tube" skin grown in a laboratory to serve as permanent grafts for victims of extensive burns. The skin is grown from tiny patches of healthy skin taken from the patient's body.

See also **Plastic surgery**.

Skink is any of a large group of small lizards that live in mild and tropical regions. There are more than 900 species of skinks. They are most common in Australia, Africa, Asia, and islands of the western Pacific Ocean.

Most skinks are active during the day. They generally hunt for small insects. A few species eat other lizards or plants. Most species of skinks live on the ground, but some species are found in trees, on rocks, or underground.

The largest skinks grow over 60 centimetres long. However, most skinks measure less than 40 centimetres. Skinks have scaly skin that may be brightly coloured or striped. Small pieces of bone within their scales provide a protective suit of armour. Most skinks have short, weak legs and move slower than other lizards. Some



The western skink, above, lives in southern British Columbia, Canada, and the Western United States. There are more than 900 species of skinks. They inhabit mild and tropical regions.

skinks that live beneath the surface have no legs at all. They burrow through soil using wriggling, snakelike movements.

Most female skinks lay eggs. In a few species, the females guard the eggs until they hatch. The females of some species bear live young.

Scientific classification. Skinks make up the family Scincidae.

Skinner, B. F. (1904-1990), was an American psychologist. He was best known for his research into the learning process and his belief in a planned society. Skinner was a leading supporter of *programmed instruction*, in which the principles of learning determined in the laboratory are applied to classroom teaching. He was also

known as a student of behavioural psychology, the study of the observable behaviour of human beings.

Burrhus Frederic Skinner was born in Susquehanna, Pennsylvania, U.S.A. He became interested in the work of the American behavioural psychologist John B. Watson and the Russian physiologist Ivan Pavlov.

In 1936, Skinner joined the faculty of the University of Minnesota. During World War II (1939-1945), Skinner designed his first "baby box," or Air Crib, a controlled environmental chamber for infants. From 1958 until 1975, Skinner was Edgar Pierce professor of psychology at Harvard University.

See also **Learning** (Instrumental conditioning); **Developmental psychology** (Theories of learning).

Skipper. See **Butterfly** (Skippers; pictures).

Skłodowska, Marie. See **Curie, Marie S.**

Skopje (pop. 503,449) is the capital of Macedonia, a country in southeastern Europe. Skopje lies in northern Macedonia, along the Vardar River (see **Macedonia** [map]). About 80 per cent of the city was destroyed or damaged by an earthquake in 1963. The city was rebuilt with earthquake-resistant construction. Structures that remain from the past include an ancient fortress, a Turkish bath, and a Muslim mosque.

Products made in Skopje include agricultural machinery, beer, bricks, cement, chemicals, glass, steel, and tobacco products. Other industries include fruit and vegetable processing, leather processing, and woodworking.

The city, originally known as *Scupi*, became an important settlement in the kingdom of Illyria about 3,000 years ago. From the A.D. 300's to the 500's, it was an economic, political, and religious centre of a Roman district. After occupation by Slavs in 695, the city received the name Skopje.

See also **Macedonia** (picture).

Skryabin, Alexander. See **Scriabin, Alexander**.

Skua, also known as *great skua*, is a bird of prey that lives for much of the year over the ocean. The skua is a fierce bird with a strong, hooked beak and brown-and-white feathers. Skuas are found far out over the sea, where they attack gulls and terns, taking the fish which these birds have caught. On land, they also eat smaller birds and their eggs.

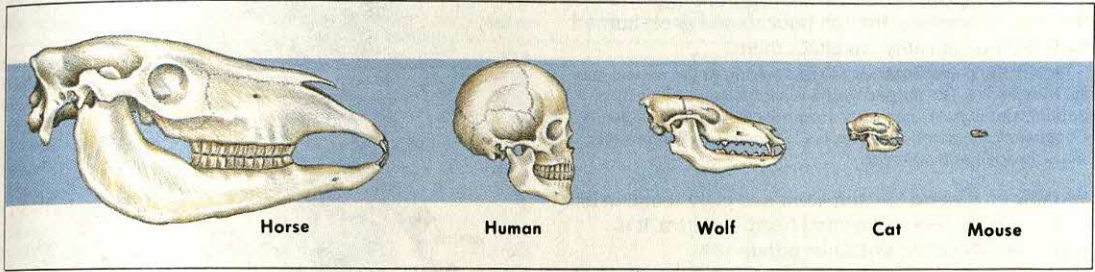
Skuas are related to the hunting gulls, or jaegers, but are larger. Skuas build their nests of sticks and grasses on the ground or on bare rocks. These birds do not conceal their nests, but they are prepared to fight to protect them.

Scientific classification. The skua belongs to the skua and jaeger family, Stercorariidae. The skua is *Catharacta skua*.

See also **Antarctica** (Animal life); **Bird** (picture: Sea birds and birds of the Antarctic).

Skull is the bony frame of the head of human beings and other animals with backbones. It is a case made up of bones that enclose the brain, and bones that form the face. The human skull has 22 bones. Eight bones enclose the brain and make up what is called the *cranium*. These eight bones are called the *cranial bones*. The cranial bones are the *occipital*, at the back of the skull; the *sphenoid*, at the base of the skull; two *parietal* bones, at the top and sides; two *temporal* bones, above the ears; the *frontal*, at the forehead; and the *ethmoid*, at the nose. The other 14 bones of the skull form the face and the jaw. They are called *facial bones*.

Comparative sizes of skulls



Except for the *mandible* (lower jawbone), all the skull bones of an adult form a rigid, united structure. But the skull bones of babies are still growing, and are soft where the bones join. But after a few years, the bones *fuse* (grow together) to form a hard, zigzag joint called a *suture*.

Animal skulls are shaped in ways that help the animal feed according to its way of life. For example, a wolf or cat has long jaws and strong, sharp teeth to grasp and tear its prey. But a horse's broad jaw and flat-edged teeth are shaped for cutting and grinding grasses and plants. The whale has a streamlined skull suited to its life in the water.

See also the Trans-Vision three-dimensional picture with **Human body**; also **Head**; **Mandible**; **Mastoid**; **Sinus**.

Skunk is a small furry animal with distinctive black and white markings. It is known for the foul-smelling liquid it sprays when frightened or in danger. The odour is very persistent, and remains for days on whatever has been sprayed.

The sprayed liquid, called *musky*, comes from a pair of glands near the base of the skunk's tail. The animal can spray accurately as far as 4 metres. Before it sprays, it gives warning by stamping or standing on its front feet and by hissing or growling. There are four main types of skunks: (1) *striped*, (2) *hooded*, (3) *hog-nosed*, and (4) *spotted*.

The striped skunk has two wide white stripes that form a large V down its back. White fur covers the top of its head, and a thin white stripe runs down the centre of its face. Most striped skunks grow from 33 to 45 cen-

timetres long, not including the tail. The striped skunk lives in North America and in northern Mexico. It is found in a variety of habitats, from arid grassland to suburban gardens.

The hooded skunk gets its name from the hoodlike ruff of long, white hairs at the back of its neck. It lives in rocky places and along streams in Southwestern United States and Central America. Its body length ranges from 56 to 79 centimetres.

The hog-nosed skunk resembles the striped skunk. But the hog-nosed skunk has a bare, protruding, piglike snout and lacks a face stripe. Some of these skunks have an entirely white back and tail. Most hog-nosed skunks grow from 36 to 48 centimetres long. Hog-nosed skunks are the only skunks found in South America. They also live in Central America and in the southwestern United States and are found mainly in scrub-covered areas of foothills.

The spotted skunk has large white blotches all over its body. A triangular patch of white marks the forehead. Spotted skunks grow from 18 to 35 centimetres long. They live in the United States and as far south as Central America.

Many skunks live in underground dens which they line with dry leaves. The spotted skunk, unlike the striped and hog-nosed species, can climb, and it sometimes lives in hollow trees. Skunks are *nocturnal* animals, that are active at night and sleep during the day. Most female skunks give birth to four or five young at a time, but litters of up to ten occur.

Skunks eat caterpillars and such insects as beetles, crickets, and grasshoppers. They also eat mice, rats, and



The **spotted skunk** is the smallest kind of skunk. It may stand on its front feet as a warning before spraying an enemy.



The **striped skunk** sprays an enemy only after giving a warning by growling and stamping its front feet.

other small rodents. Sometimes they eat eggs, fruit, grain, and the rotting flesh of dead animals. Skunks have few natural enemies, though bobcats and great horned owls have been known to attack them.

Scientific classification. Skunks belong to the weasel family, Mustelidae. The striped skunk is *Mephitis mephitis*. The hooded skunk is *M. macroura*. Hog-nosed skunks form genus *Conepatus*. A common species is *C. leuconotus*. The spotted skunk is *Spilogale putorius*.

Skunk cabbage is a soft-stemmed plant found in low swamps in eastern and central North America. It is known for its heavy, skunklike odour.

Skunk cabbage is called a *perennial* because its roots send up new stems each year. The roots are heavy and coarse. The small flowers grow in a thick spike, which is surrounded by a brown leaflike organ called a *spathe*. The spathe gives off an unpleasant odour. The leaves of the skunk cabbage are broad and 30 to 90 centimetres long. The leaves grow in tufts.

Scientific classification. The skunk cabbage belongs to the arum family, Araceae. It is *Symplocarpus foetidus*.

Sky is the region of space visible from the earth. The sky consists of the atmosphere, which extends hundreds of kilometres above the earth. The atmosphere is composed chiefly of nitrogen and oxygen. In addition, it contains tiny water droplets and ice crystals in the form of clouds and precipitation. Smoke, dust particles, and chemical pollutants may also fill the sky over cities.

The colours of the sky result from the scattering of sunlight by the gas molecules and dust particles in the atmosphere. Sunlight consists of light waves of varying wavelengths, each of which is seen as a different colour (see **Light** [Electromagnetic waves]). The shortest light waves appear blue and the longest red. The blue light waves are readily scattered by tiny particles of matter in the atmosphere, but the red light waves travel undisturbed unless they are struck by larger particles.

When the sky is clear, the waves of blue light are scattered much more than those of any other colour. As a result, the sky appears blue. When the sky is full of dense clouds or smoke, the light waves of all colours are scattered, causing the sky to turn grey. At sunrise or sunset, sunlight must travel farther through the atmosphere than when the sun is overhead. Light waves of most colours are scattered. Undisturbed red light waves give the sun and sky near the horizon a red or orange appearance.

Skydiving is a sport in which one or more people jump from an aeroplane and fall freely before opening a parachute. Skydivers typically jump at altitudes of up to 4,600 metres and fall at speeds of more than 160 kilometres per hour. They open their parachutes at 600 to 900 metres and then glide to earth at about 16 kilometres per hour.

In *accuracy skydiving*, the jumper aims for a target that measures about 5 centimetres in diameter. In *relative work skydiving*, a team of free-falling skydivers join together to make geometrically shaped formations.

Skye and Lochalsh (pop. 12,541) is a local government district in the western part of Highland Region, Scotland. It includes part of the Scottish mainland and the island of Skye. The district's great scenic beauty and several interesting castles make it a leading tourist area. A car ferry links Skye with the mainland. Most of the dis-



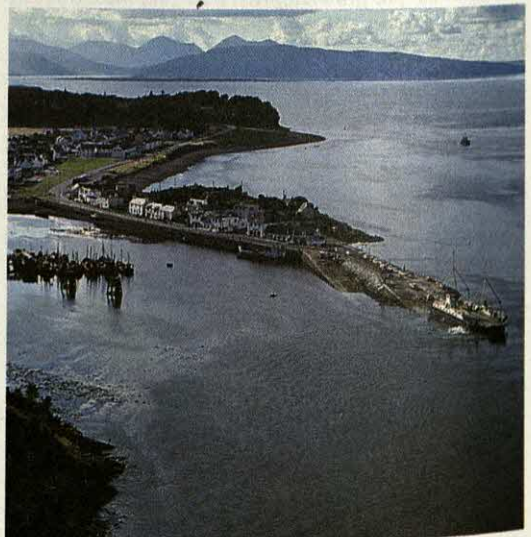
Daring skydivers make a controlled free fall before opening the parachutes that allow them to float safely to the ground.

trict's workers are employed in farming, fishing, forestry, or tourism. There is a Royal Navy base at Kyle of Lochalsh.

See also **Cuillin Hills; Hebrides; and Highland Region.**

Skye terrier is one of the oldest terrier breeds. It originated during the 1600's on the island of Skye, off Scotland. It is a good housepet and a good rat hunter. The Skye is only 20 to 25 centimetres high, but its body is about 56 centimetres long. It has long hair that hangs down over its eyes. Its ears may be either erect or hanging. Its coat is about 13 centimetres long and may be dark or light blue, grey, or fawn.

See also **Dog** (picture: Terriers); **Terrier.**



On the Isle of Skye, small villages and fishing boats blend perfectly with the beautiful, peaceful scenery of the area.

The world's tallest skyscrapers

Name of building	City	Storeys	Height to roof In metres	Total height* In metres
Sears Tower	Chicago	110	443	520
World Trade Center	New York City	110	411	411
Empire State	New York City	102	381	443
Amoco	Chicago	80	346	346
John Hancock Center	Chicago	100	344	450
First Interstate World Center	Los Angeles	75	310	310
Texas Commerce Tower	Houston	75	305	305
Bank of China	Hong Kong	73	305	369
Allied Bank Plaza	Houston	71	302	302
Columbia Seafirst Center	Seattle	76	291	291
Two Prudential Plaza	Chicago	64	288	303
Bank of Montreal Tower	Toronto	72	285	290
NCNB Plaza	Dallas	72	281	281
Overseas Union Bank	Singapore	60	280	280
Citicorp Center	New York City	46	279	279
Scotia Plaza	Toronto	68	276	277
Transco Tower	Houston	64	275	277
AT&T Corporate Center	Chicago	60	271	271
900 North Michigan	Chicago	68	267	267
311 S. Wacker	Chicago	65	265	295
Chrysler	New York City	77	264	319

*Includes spire, statue, television antenna, or other structure on roof.

Skyjacking. See Hijacking.

Skylab. See Space travel (Space stations).

Skylark. See Lark.

Skyscraper is the name given to the tallest buildings in big cities. These giant structures were first built in Chicago and New York City, because the high price of land and the limited space made it necessary to build upwards. The development of lightweight iron girders capable of supporting many floors made the skyscraper possible.

William Le Baron Jenney designed the first metal-frame skyscraper, the Home Insurance Building in Chicago. The structure was built in 1884 and 1885, and demolished in 1931. Skyscrapers are now made of steel and concrete.

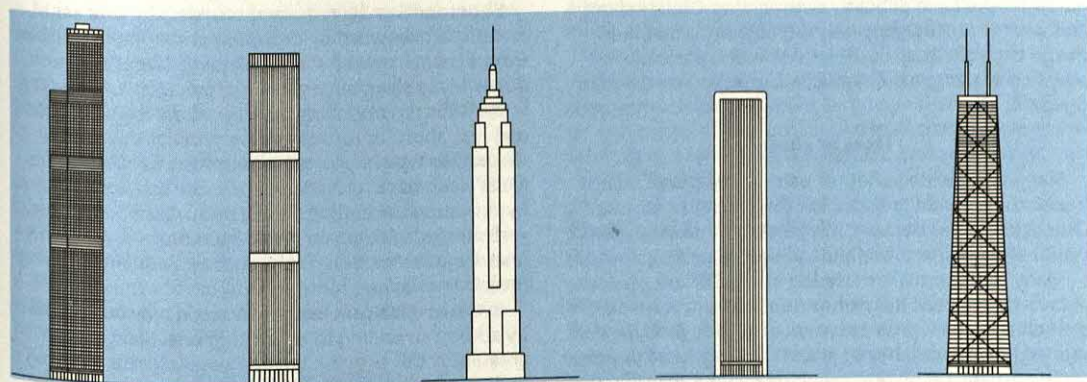
Related articles in World Book include:

Architecture	Jenney, William Le Baron
Building construction	Lift
Burnham, Daniel H.	Mies van der Rohe, Ludwig
Empire State Building	Sullivan, Louis Henri

Slag is the nonmetallic material removed in the process of making pig iron, and in smelting copper, lead, and other metals. The slag from steel blast furnaces contains sulphur and silicates of calcium, magnesium, and aluminium. The slag from copper and lead-smelting furnaces contains iron silicate, and oxides of other metals in small amounts. Slag from steel furnaces contains lime, iron oxide, and silica. Often it is smelted again to recover the iron. Slag is sometimes used in the manufacture of cement and the building of roads.

The world's five tallest skyscrapers

Skyscrapers are found in many of the world's major cities. The five tallest skyscrapers are pictured below. The heights given show the distance from the pavement to the roof. They do not include antennas or other roof structures.



Sears Tower
Chicago
443 metres

World Trade Center
New York City
411 metres

Empire State Building
New York City
381 metres

Amoco Building
Chicago
346 metres

John Hancock Center
Chicago
344 metres

Slalom. See **Skiing** (Alpine competitions).

Slander is a spoken untruth that injures a person's reputation. Writing or printing a similar statement is called *libel*. There is confusion whether spoken untruths on radio and television are libel or slander. But the trend is to treat such spoken untruths as libel.

A person who believes he or she has been slandered can sue for damages in a civil court. To win such a suit, the *plaintiff* (person filing the charges) must prove that a false statement caused either a loss of money or injury to character.

See also **Libel**.

Slaney is a river in the Republic of Ireland. It rises in the Wicklow Mountains and flows south for 100 kilometres through Carlow and Wexford. The Slaney empties into the Irish Sea at Wexford Harbour. Important salmon fisheries are situated near Wexford.

Slang is an informal kind of language in which words and phrases are used in new or unusual ways. Many slang terms are expressive, humorous, and vivid. Some are crude and offensive. A slang expression may be a new word, such as *glitzy* (gaudy) or *hype* (advertising that relies on gimmicks or tricks). Or it may be an old word with a change of meaning, such as *magic* (wonderful) or *cool* (sophisticated and self-controlled).

People use slang more often in speaking than in writing, and more often with friends than with strangers. Slang thus resembles *colloquialisms*, which are expressions used in everyday conversation but not considered appropriate for formal speech or writing. Unlike colloquialisms, however, most slang lasts only a few years. Also, nearly all colloquialisms are used—or at least understood—by the general population. But many slang expressions are limited to a certain segment of society or to a specific occupational group. For example, some slang is used only by criminals and other members of the underworld. Such slang is called *argot* or *cant*. The special slang and technical vocabulary of a profession or trade is known as *jargon*.

Some slang expressions are phrases whose meaning cannot be determined from the ordinary meanings of the words. Such expressions, including *kick the bucket* (to die) and *up the creek* (in trouble), are called *idioms* (see **Idiom**).

Slang expressions change and spread so quickly that many people have difficulty determining what is slang and what is not. In many cases, dictionaries and language experts disagree about whether a particular expression is slang, a colloquialism, or even standard language.

Uses of slang

Slang has a wide variety of uses. Many people use it because they want to seem fashionable and modern. Others use slang because it is frank and informal, expresses friendliness, and puts people at ease.

Many slang terms are used to insult. For example, a person considered inferior or unpleasant can be described by such words as *creep*, *drip*, *fink*, *jerk*, *nerd*, *sap*, and *twit*. A number of insulting slang words refer to certain ethnic, racial, and religious groups. Slang is also used to criticize or poke fun at established institutions. In the United Kingdom, for example, the British Broadcasting Corporation (BBC) is sometimes called *Auntie*.

Some slang expressions are used chiefly by members of certain groups. In the jargon of airline pilots, for example, passengers are called *geese*. Truckdrivers have a large slang vocabulary, including such expressions as *ears* (citizens band radio), and *hammer* (accelerator). Different age groups also have different slang. An adult might describe something big as *mega*. A child might describe a large object as *ginormous*.

Group slang is often used to demonstrate membership in—and loyalty to—the group. This type of slang may also be used to maintain secrecy because outsiders are unfamiliar with it. In a hospital, a doctor may ask a nurse to put a patient on the *bird* (respirator) or to have some laboratory tests performed *stat* (in a hurry). Such slang not only shows that the doctor and nurse belong to the medical profession but also may keep the patient from becoming alarmed. Similarly, much underworld cant developed in an effort to keep outsiders from knowing what criminals were talking about.

Many slang expressions help people express themselves vividly and humorously. For example, a student who says, "Maths drives me up the wall!" probably sounds more convincing than one who says, "I dislike mathematics."

People often use slang to refer to painful or frightening situations. A soldier may say that a friend *bought it* rather than was killed in battle. Workers who have been dismissed from their job may say they were *fired* or *sacked*. Such language attempts to relieve anxiety by substituting a light-hearted or indirect expression for an unpleasant or direct one.

Forms of slang

Slang expressions arise in the same ways that other words come into being. There are seven chief forms of slang, each created by a different process. These forms are (1) old words used in new ways, (2) shortened or lengthened words, (3) figures of speech, (4) rhyming slang, (5) acronyms, (6) coinages, and (7) blends.

Old words used in new ways. Most slang expressions are simply new uses for old words or phrases. The *flap* (excitement or commotion) about air pollution is slang, but the *flap* (hinged section) of an aeroplane wing is not. To *rip off* (steal) a camera is slang, but to *rip off* the top of a box is standard English.

Shortened or lengthened words. The process of creating a new word by dropping one or more syllables from a longer word is called *clipping*. Clipping produces many slang terms, including *phizog* (face), which is short for *physiognomy*; *psycho*, short for *psychopath*; and *rep*, short for *representative*.

Another type of shortened word is a *back-formation*. Most slang back-formations are verbs that were formed by dropping the ending from a noun. Examples of such verbs include *burgle* (to steal), from *burglar*; *leech* (to lust), from *lecher*; and *nuke* (to attack with nuclear weapons), from *nuclear*.

In the reverse process, a new word may be created by adding an ending to an existing one. Slang words created by this process include *payola* (graft), from *pay*; and *slugfest* (fight), from *slug* (to hit).

Figures of speech are expressions in which words are used in unusual ways. One of the most common slang figures of speech is the *metaphor*, an implied

comparison between two different things. For example, the slang expression *three sheets to the wind* compares drunkenness to a sailing ship. Other slang metaphors describe a tall, thin person as a *bean pole* and a talkative person as a *windbag*.

Another type of slang figure of speech is *metonymy*, which substitutes a quality of something for the thing itself. The expression *greenbacks*, for example, is a metonym for paper currency.

Rhyming slang is slang that replaces a word with a word or phrase that rhymes with it. Many cockneys in Great Britain and large numbers of Australians use such slang. For example, a cockney might say *Rosie Lee* for *tea*, or *apples and pears* for *stairs*. Some American slang is also formed by rhyming. Examples are *crumb-bum* (inferior person) and *thriller-diller* (exciting story or film).

Acronyms are words formed from the first letters or syllables of the words in a phrase. This form of slang includes *D. J.* or *deejay*, from *disc jockey*.

Coinages are newly invented words or phrases. Slang coinages include *mazuma* or *moolah* (money) and *plonk* (inferior wine).

Blends are new words created by joining the first part of one word to the second part of another. An example of a slang blend is *exploitation* (commercial exploitation of people's interest in sex).

Diminutives are slang words formed from clipped versions of words with an *-ie*, *-y*, or *-o* ending added to them. Thus Australians, who may be called *Aussies*, speak of a piece of galvanized iron as a *galvo*.

Sources of slang

Much slang comes from the special vocabulary of certain groups within a general population. These groups may be based on such factors as age, ethnic background, and occupation. A large amount of cant, jargon, and other group language spreads beyond the group that originated it and becomes general slang. The term *scam* (to get away quickly) originated as criminal argot. Theatre jargon produced such expressions as *ham it up* (to overact) and *turkey* (failure). Jazz musicians in America invented *gig* (job) and *bag* (special interest or talent). Black Americans contributed many expressions, including *dig* (to understand), *rap* (to have a serious discussion), and *nitty-gritty* (the basics).

Many slang expressions in English have their origins in other languages. *Bolshie* (rebellious) comes from the Russian *bolshevik*. *Ersatz* is a German word meaning synthetic, but it is used in English to mean an inferior imitation. Yiddish was the source of such terms as *dreck* (junk) and *klutz* (clumsy person).

All slang expressions were invented by someone, but only a few can be traced to a specific person. Jack Conway, a writer for the American entertainment newspaper *Variety*, invented *pushover* (something easy) in the early 1900's. The American science fiction writer Robert A. Heinlein introduced *grok* (meaning to understand and communicate deeply) in *Stranger in a Strange Land*, a novel published in 1961.

The spread of slang

Most slang spreads by word of mouth, and so the paths of many expressions are difficult to trace. Language scholars have found that much slang originates in

social groups that have lower incomes, less education, and less power than the rest of society. For example, many expressions spread from young people or from minority groups to the larger society. There are exceptions, however. Some slang comes from highly trained professional people, such as aerospace scientists and computer experts.

Radio and television also spread a great deal of slang. A TV entertainer introduces a new slang expression to millions of people at once, giving it almost instant popularity.

Nearly all slang expressions die out soon after they become widely used. For example, *crazy* (wonderful) had a short period of popularity in the 1950's. On the other hand, some slang terms last so long and become so widely used that they are considered colloquialisms. Examples include *belly laugh* (heartily laughter) and *half-baked* (not fully worked out).

A few slang expressions even become part of the standard language. For example, the word *hairdo* was introduced in the 1920's as a slang term for coiffure and became a standard word in less than 20 years. The words *hoax* and *strenuous*, which also began as slang, took longer to be accepted. Some slang words have been used for hundreds of years without reaching the status of colloquialisms or standard words. For example, *grub* (food) dates back to the 1600's, and *lousy* (bad) dates back to the 1700's. However, both of these words are still considered slang.

Attitudes toward slang

Many people disapprove of slang. They consider it inferior language and accuse those who use it of careless, lazy thinking. Some believe the use of slang limits a person's vocabulary and even weakens the standard language itself. Much of slang's bad reputation comes from the company it keeps. Some people assume that slang is stupid and vulgar because it frequently occurs in informal conversation, accompanied by grammatical errors and profanity.

Most people agree that slang can easily be overused and misused. A slang term becomes tiresome if it is repeated too often. Likewise, slang is inappropriate for certain uses, including formal speeches, business letters, and schoolwork. A slang expression can also cause a loss of accuracy in communication because it may mean different things to different people.

However, the reasonable use of slang promotes lively speaking and writing. Slang is an important part of any language and helps keep a language fresh and alive. A great number of colourful and useful words have come from slang, including *bootleg*, *jazz*, and *skyscraper*.

See also **Dialect**.

Slapstick comedy. See **Humour**; Sennett, Mack.

Slash-and-burn agriculture. See **Agriculture** (Shifting cultivation); **Indian, American** (Farming); **Indonesia** (Agriculture).

Slate is a fine-grained rock that can easily be split into thin, durable sheets. It consists mainly of grains of mica and quartz, plus smaller amounts of chlorite, haematite, and other minerals. Most slate is grey to black in colour, but the rock may be red or purple, depending on its mineral content.

Slate is a *metamorphic rock* (see **Metamorphic rock**).

Most slate is formed below the earth's surface by changes in the makeup and appearance of shale, a *sedimentary rock* (see *Sedimentary rock*; *Shale*). Shale consists of clay and fine particles of quartz. Heat from deep in the earth changes some of the clay in shale into mica and chlorite. Slate results when pressure created chiefly by mountain-forming movements in the earth's crust squeezes the mica and other minerals into parallel layers.

Much slate occurs in Scotland, Wales, France, southern Germany, and the Northeastern United States. The building industry uses slate for roofing and flagstones because the rock is weatherproof and long-lasting. Slate is also used to trim the fronts and lobbies of buildings. **Slater, Samuel** (1768-1835), a British textile worker, founded the textile industry in the United States. Slater was born in Derbyshire. He moved to the United States in 1789, after working for six years as an apprentice and manager in an English textile mill. At the mill, he learned the workings of the spinning machine developed by the British inventor Richard Arkwright. Slater left England in disguise because the British government prohibited any person who had knowledge of the design and operation of spinning machines from leaving the country. With this policy, Great Britain sought to maintain its world leadership in the production of textiles.

In 1790, Slater agreed to build the Arkwright machine from memory for Almy & Brown, a Rhode Island textile firm that wanted to use mechanical spinning techniques. Slater soon formed a partnership with Almy & Brown. The firm established the first successful spinning mill in the United States at Pawtucket, Rhode Island, in 1790. Slater supervised the mill and hired children aged from 7 to 14 to operate the equipment. In 1798, Slater established his own firm, Samuel Slater and Company, at Rehoboth, Massachusetts. By the time of his death, Slater operated a number of mills in Connecticut, Massachusetts, New Hampshire, and Rhode Island.

Slave Lake, Great. See *Great Slave Lake*.

Slavery is a practice in which people own other people. A slave is the property of his or her owner and works without pay. The owner, who is called a *master* or *mistress*, provides the slave with food, shelter, and clothing.

Slavery began in prehistoric times and has been practised ever since. The slavery of ancient times reached its peak in Greece and the Roman Empire. During the Middle Ages, slavery declined. Then, during the 1500s and 1600s, the colonization of the New World by Europeans resulted in a great expansion of slavery. Changing moral attitudes to slavery helped to cause its decline during the 1800s. Today, slavery is illegal in almost every country. But it still exists in parts of Africa, Asia, and South America.

Development of slavery

The start of slavery probably followed the development of farming about 10,000 years ago. Farming gave people an opportunity to put their prisoners of war to work for them. People captured in war continued to be the chief source of slaves in the earliest civilizations. Other slaves were criminals or people who could not pay their debts.

Ancient times. The first known slaves formed the

lowest class in the civilization developed by the Sumerians in Mesopotamia (now mostly Iraq) about 3500 B.C. Slavery also existed in Assyria, Babylonia, Egypt, Persia, and other ancient societies of the Middle East. In addition, it was practised in ancient China and India and among the early blacks of Africa and the Indians of America.

Slavery expanded as commerce and industry increased. This growth of trade created a demand for a disciplined labour force that could produce goods for export. As a result, ancient slavery reached its fullest development in the great empires of Greece and Rome. Slaves did most of the work in these societies. Many laboured in handicraft industries, in mines, or on plantations. Others worked as household servants, and some even became doctors or poets. During the 400s B.C., slaves may have made up a third of the population of Athens. In Rome, slavery became so widespread that even common people owned slaves.

Most people of the ancient world regarded slavery as a natural condition of life that could befall anyone at any time. Few writers or other influential people viewed it as evil or unjust.

The treatment of slaves varied greatly, but almost no slaves could legally marry, have a family, testify in court, or own property. In ancient Greece and the Roman Empire, slaves who worked in large gangs in mines or on plantations served long hours and suffered harsh punishment. However, many of those who worked as household servants were treated as well as any member of the owner's family.

A slave's chief hope was *manumission* (formal release from slavery by the owner). Most ancient slaveholding societies allowed manumission, and many owners guaranteed it in their will as a reward for loyal service.

The Middle Ages. After the Roman Empire broke up in the A.D. 400s, international trade fell sharply. The loss of markets for goods that slaves might have produced led to a decline in the need for slaves. In Europe, slavery slowly changed into serfdom (see *Serf*).

But slavery continued in the areas around the Mediterranean Sea. Most of it resulted from fighting between two religious groups, Christians and Muslims. During the A.D. 600s and early 700s, Arab Muslims conquered the Middle East, North Africa, and almost all of Spain. Christians and Muslims fought each other in these areas for hundreds of years, and both groups enslaved their prisoners. Some of the fighting occurred during the Crusades—the Christian attempts to recapture Jerusalem and other areas of the Holy Land from the Muslims. The Crusades began during the 1000s.

In the Holy Land, the crusaders tasted sugar for the first time. Many of them then created a demand for sugar after returning to Europe. As a result, Italian merchants established sugar plantations on several Mediterranean islands. The production of sugar required large numbers of labourers, and so the Europeans imported slaves from Russia and other parts of Europe. By 1300, a few African blacks had begun to replace Russian slaves on Italian plantations. These blacks were bought or captured from North African Arabs, who had enslaved them for years.

During the 1400s, Portuguese sailors started to explore the coast of West Africa and to ship African blacks

to Europe as slaves. The Portuguese also enslaved blacks on sugar plantations that they established on islands off the coast of West Africa.

Throughout the Middle Ages, various peoples in Africa and Asia continued to enslave prisoners of war. During this period, slavery was widely practised among three groups of Indians. These Indians lived on islands of the Caribbean Sea and also inhabited what are now the northwest coast and eastern woodlands of the United States. Most slaves in the Indian societies worked as farmers or domestic servants. They generally suffered less hardship than the slaves who toiled on European sugar plantations.

Modern times. The establishment of European colonies in the New World during the 1500's brought an expansion of slavery. The Spaniards developed sugar plantations in Cuba and on other Caribbean islands that became known as the West Indies. The Spaniards also needed large numbers of labourers to mine gold and other metals. Portuguese colonists started huge sugar plantations in Brazil. These Europeans enslaved thousands of Indians. But most of the Indians died from European diseases and harsh treatment. The Spaniards and the Portuguese then began to import blacks from West Africa as slaves. Other African blacks helped capture most of the enslaved Africans.

During the 1600's, France, England, and the Netherlands established colonies in the West Indies and greatly increased the African slave trade. Soon, the Europeans enslaved only blacks. Sugar became the main export of the European colonies, though the settlers also developed profitable coffee, cotton, and tobacco plantations.

The rising European demand for sugar helped create fierce competition for slaves and for new sugar colo-

nies. From the 1500's to the 1800's, the Europeans shipped about 12 million black slaves from Africa to the Western Hemisphere. Nearly 2 million of these slaves died on the way. About 65 per cent of the slaves were brought to Brazil, Cuba, Jamaica, Saint Domingue (now Haiti), and other sugar colonies. Brazil alone received about 38 per cent. North America got about 6 per cent. See *Africa* (The beginnings of European control).

Laws in the European colonies of Latin America showed considerable concern for the welfare of slaves. These laws allowed slaves to marry, to seek relief from a cruel owner, and even to buy their freedom. Such laws were rarely enforced, however. Partly for this reason, slavery was as cruel in Latin America as it was, later, in the United States. But slaves in the United States generally ate better, lived longer, received better medical care, and had a more secure family life than those in most other countries.

The continual shipment of large numbers of Africans to Latin America gave slaves there certain advantages over blacks taken to the United States.

Slaves in Brazil and the West Indies had less need to adjust to white culture than did blacks in the United States. Blacks greatly outnumbered whites in parts of Brazil and in most West Indies colonies, but the Southern United States had twice as many whites as blacks. The greater number of slaves than whites in those Latin American areas also made slave revolts more common there than in the United States. The biggest slave revolt in history broke out in Saint Domingue in 1791. Nearly 500,000 slaves rebelled against their French owners and took over the country. See *Haiti* (History).

Slavery in the United States

The enslavement of blacks in the American Colonies began during the 1600's. Slavery flourished in the South, where large plantations grew cotton, tobacco, and other crops. The plantations required large numbers of labourers. But slavery was less profitable in the North, where economic activity centred on small farms and industries.

By 1860, the slave states had about 4 million slaves. The slaves made up nearly a third of the South's population.

Views of slavery. During the 1700's, noted philosophers and religious leaders in Europe and North America began to condemn slavery. They declared that slavery violated human rights and God-given law.

Many Americans turned against slavery during the American Revolution (1775-1783). These Americans came to believe that slavery had no place in a nation that had been formed to protect natural human rights. Few people in the North owned slaves, and opposition to slavery developed more rapidly there than in the South. Some Southerners, including such leaders as George Washington and Thomas Jefferson, spoke out against slavery. But the high profits that resulted from slavery had far greater influence than did any moral arguments.

Support of slavery remained strong throughout the South. But only about a fourth of the region's whites owned slaves or belonged to a family that owned them. About 45,000 planters owned over half the slaves, and these planters controlled the economy and government of the Southern States. Even the many Southerners who



People captured in warfare became the chief source of slaves in ancient Rome, above, and other early slaveholding societies. Today, slavery still exists in parts of Africa, Asia, and South America.

did not own slaves accepted the planters' view that the South's economy would collapse without slavery.

During the early 1800's, abolitionists started a crusade to end slavery. Southerners then began to defend slavery in what became known as the *proslavery movement*. By 1860, most Southerners identified their honour and destiny with the continuation of slavery.

Functions of slaves. During the 1600's and 1700's, most slaves in what became the Southern States worked on plantations that grew chiefly indigo, rice, or tobacco. The invention of the cotton gin in 1793 resulted in fast, large-scale production of cotton. This fibre was the raw material most needed by American and British industry. The high demand for cotton led to the establishment of cotton plantations throughout the American South.

During the 1800's, most of the plantation slaves were *field hands* who planted and picked cotton. *House slaves* worked as servants in the owner's home. Other plantation slaves became skilled craftworkers such as blacksmiths, bricklayers, cabinetmakers, or carpenters.

Slaves also had a variety of jobs in Southern cities and towns. Many worked in factories. Others became construction workers on canals and railways or worked as dockworkers, lumberjacks, office workers, or riverboat pilots. Still others toiled in mines.

Conditions of slavery. Owners housed their slaves and provided them with food and clothing. The amount and quality of these provisions varied widely.

Field hands worked longer than any other kind of slave. Their working day generally lasted from sunrise to sunset. Some of these slaves were housed as well as free workers. But many other field hands lived under the worst conditions.

Most house slaves lived in their owner's home. They worked fewer hours and had more privileges than did field hands, but were more subject to the wishes of the owner's family. Most slaves who in time were freed by their owner had worked as house servants.

No Southern state gave slaves the legal right to marry, own property, testify in court, or earn their freedom. Yet some slaves did all these things. To encourage faithful service, some slaveholders treated their slaves kindly and promised them such privileges as gifts and money. Other owners relied on punishment, such as lashings, short rations, and threats to sell members of the slave's family.

The religion of the slaves, a mixture of African and Christian beliefs, made the slaves feel part of a community. State laws prohibited the education of slaves. But the slaves developed their own language, music, and other means of communication.

Many slaves tried to run away to freedom. Thousands succeeded, including those who followed the runaway slave Harriet Tubman along an escape system called the *underground railroad*. Some slaves joined organized rebellions, but whites easily crushed most revolts.

Effects of slavery included a major role in the economic development of the United States. Slaves helped clear the wilderness and build important canals, railways, and roads. The cotton picked by slaves became America's most valuable export. The income from cotton paid for a major share of U.S. imports.

The westward expansion of slavery during the early and mid-1800's had important political effects. Northern-

ers feared that the South would gain control of Congress if Western territories entered the Union as slave states. Attempts by the North to exclude slavery from these territories angered the South and helped bring on the American Civil War (1861-1865).

After the Civil War, discrimination and a lack of education prevented most former slaves from obtaining a good job. Discrimination also kept them from receiving the civil rights they legally had been granted.

The decline of slavery

During the late 1700's, black slavery began to decline in various parts of the Western Hemisphere. The American Revolution helped cause gradual *emancipation* (freeing of slaves) in the North. In 1807, the British Parliament passed a bill outlawing slave trade. The U.S. Congress prohibited the importation of African slaves into the United States in 1808.

During the early 1800's, most of Spain's Latin-American colonies won wars of independence. These countries immediately abolished slavery or adopted laws for gradual emancipation. Slavery was abolished in the British colonies between 1834 and 1840. In 1848, France freed the slaves in its remaining colonies in the Western Hemisphere. But slavery continued to expand in Brazil, Cuba, and the Southern United States. During the American Civil War, Northern armies freed most of the slaves in the nation. Adoption of the 13th Amend-

The North American slave trade

The map on the right shows the route ships used to carry slaves from western Africa to North America. On the map below, the red type indicates the groups from which most slaves were taken. The groups that captured the most Africans for European and American slave traders are shown in bold black type.





Slaves who picked cotton on plantations in the United States during the 1800's usually worked from sunrise to sunset.

ment to the Constitution completed abolition in 1865. Spain ended slavery in Puerto Rico in 1873 and in Cuba in 1886, and Brazil abolished slavery in 1888.

Today, few nations legally allow slavery. But slavery does continue in areas of Africa, Asia, and South America. No one knows exactly how many people still live in slavery. Most of these slaves are blacks and Indians who were captured in local conflicts or were sold to satisfy debts. Slavery remains a strongly accepted custom among the people who practise it. Therefore, some governments may not want to stop slavery, and others may be unable to end it even if they wished to do so.

Slavic countries are nations where most of the people are Slavs (see **Slavs**). They include the Czech Republic, Poland, Slovakia, and Slovenia in central Europe; Bosnia-Herzegovina (sometimes called Bosnia and Herzegovina), Bulgaria, Croatia, Macedonia, and Yugoslavia in southern Europe; Belarus and Ukraine in eastern Europe; and Russia, which lies partly in eastern Europe and partly in Asia.

Slavs are any of several groups of peoples, most of whom live in eastern Europe. There are about 275 million Slavs. They speak similar languages, called the Slavic or Slavonic languages.

The first Slavs may have lived more than 5,000 years ago in a region that now forms part of northwestern Ukraine and southeastern Poland. From the A.D. 200's to the 500's, they migrated to other parts of Europe. Some Slavs settled in what is now western Russia and other parts of eastern and central Europe. Other Slavs migrated to the region of southeastern Europe known as the Balkans.

During the 800's, the Slavs established the Great Moravian Empire, which united the peoples of central Europe for the first time. In 906, the empire was conquered by the Magyars, the ancestors of the Hungarians. Since then, some of the Slavs have been ruled by a number of foreign powers, including the Byzantine Empire, the Holy Roman Empire, Austria-Hungary, and Germany.

In 1918, after World War I ended, the Slavs established such independent states as Czechoslovakia, Poland, and what later became Yugoslavia. Germany conquered these Slavic states during World War II (1939-1945).

Historians classify the Slavs into three main groups—(1) East, (2) West, and (3) South—based on the region in which these people live.

East Slavs consist of the Belarusians, or White Russians; the Russians, or Great Russians; and the Ukrainians, or Little Russians. The East Slavs were strongly influenced by the culture of the Byzantine Empire (see **Byzantine Empire**). About A.D. 988, the ruler of the East Slavs, Grand Prince Vladimir I, also spelled Volodymyr, became an Orthodox Christian. He married a Byzantine princess. Most of the people under his rule also turned to Christianity. Today, many East Slavs belong to Eastern Orthodox Churches.

West Slavs form a group that includes the Czechs; the Slovaks; the Poles; and the Wends, who are also known as Sorbs or Lusatians. The Wends live in eastern Germany. During the 800's, two Greek monks, named Cyril and Methodius, converted many West Slavs to Christianity. At that time, church services were held in Greek or Latin, which few people could understand. But Cyril and Methodius held services in a version of the language of the Slavs, which is now called *Old Church Slavonic*.

As the West Slavs became involved in the affairs of western Europe, they also became influenced by the Roman Catholic Church. Through the centuries, the Catholic Church has strongly influenced western European culture. Today, most West Slavs are Roman Catholics.

South Slavs are a group composed of the Bulgarians, the Croats, the Macedonians, the Serbs, and the Slovenes. During the 800's, a large number of South Slavs were converted to Christianity by followers of Cyril and Methodius. However, these Slavs were also strongly influenced by the Byzantine culture. Today, the majority of South Slavs belong to Eastern Orthodox Churches. Most South Slavs live in the Balkans.

See the *People* section of the articles on various Slavic countries such as **Bulgaria** and **Poland**. See also **Russian language**.

Sledge is a vehicle that has parallel runners instead of wheels, so that it can move easily over ice or snow. Sledges can be used for sport, but in some parts of the world where the climate is cold they are also an important means of transport. When sledges are used for sport they are usually coasted down an incline such as a hillside. But sometimes specially constructed inclining slides are prepared for sledging.

In the countries of the far north, where snow and ice cover the ground for many months of the year, sledges are the chief means of transport for both people and goods. In parts of Alaska and the Yukon, people travel on sledges pulled by teams of huskies. The husky is a strong working dog with tremendous stamina.

Alaskan sledges are built to stand the roughest travel. The most common Alaskan sledge is the *Nome sledge*, a long, narrow type with basket-like sides. A good team of dogs, hitched to a *Nome sledge*, can haul a 450-kilogram load. The *Nansen sledge*, made of wood and

lashed with rawhide, is wider and lighter than the Nome sledge. But a 14-kilogram Nansen sledge can carry a 270-kilogram load.

Large sledges drawn by horses or reindeer are often called *sleighs*. The Russians use sleighs drawn by horses or reindeer and call them *troikas*. In Lapland, reindeer are harnessed to open sledges used for carrying heavy goods. Small sledges are sometimes called *sleds*.

Early man made crude sledges from logs. He tied these together and dragged them along the ground. Later, men found that the sledge would move more easily and quickly if *runners* (thin slats of wood) were fastened beneath the logs. Until the wheel was invented, sledges were an important means of travel over all sorts of terrain.

The sledge used by North American Indians looked rather like a canoe on runners. It was called a *toboggan*. Early settlers in America made sledges of a box set on a pair of runners, usually drawn by oxen.

See also **Bobsledding**; **Luge**; **Tobogganing**; **Troika**; **Snowmobile**.

Sleep is a period of rest during which the sleeper loses awareness of his or her surroundings. Sleep, unlike a coma, is easily ended. A sleeping person or animal can be awakened quickly by, for example, a loud noise or a bright flash of light. All human beings and many kinds of animals must have a certain amount of daily sleep at regular intervals.

What happens during sleep. When a person falls asleep, all activity decreases and the muscles relax. The heartbeat and breathing rate slow down. The person slowly becomes less aware of what may be happening all around.

A sleeping person changes the position of the entire body at least a dozen times during about eight hours of slumber. The head, arms, or legs are moved even more often.

Scientists study sleep with an instrument called an *electroencephalograph* (see **Electroencephalograph**). Whether a person is awake or asleep, the brain gives off electrical waves. An electroencephalograph measures and records these waves. The brain of an awake, relaxed person gives off about 10 small waves a second.

As a person falls deeply into sleep, the brain sends out slower but larger and larger waves. The slowest, largest waves occur during the first two or three hours of a period of sleep. During slow-wave sleep, mental activity slows down but does not stop. People awakened from slow-wave sleep can often recall unclear thoughts that they had while asleep.

Periods of small fast waves, similar to those of an awake person, occur at intervals during sleep. During these periods of fast brain wave activity, the sleeper's eyes move rapidly as though they were watching the events of a dream. A sleeper who is awakened during such a period probably will recall dreaming and remember details of the dream. Sleep during these periods is called *dreaming sleep* or *REM* (Rapid Eye Movement) *sleep*. An eight-hour period of sleep includes from three to five periods of dreaming sleep. The dreaming sleep periods last from 5 to 30 minutes each and occur every 90 to 100 minutes. The later dream periods last longer than the earlier ones.

Human sleep patterns. Most adults sleep from 7 to 8½ hours every night. Some people, especially those who work at night, sleep during the daytime. Some adults may need as little as 6 hours sleep a night—or even less. But others may require 9 hours sleep—or even more. Most people tend to need slightly less sleep as they grow older. A person who slept 8 hours a night at 30 years of age may need only 7 hours of sleep at the age of 60.

A person's sleeping patterns develop gradually. New-born babies sleep for brief periods throughout the day and night. Their sleep periods include dreaming sleep. By the age of 2 or 3 months, babies have learned to sleep through the night, though they nap for periods during the daytime. By the age of 6, most children have given up daytime naps. Four-year-olds average from 10 to 14 hours of sleep a day, and 10-year-olds average from 9 to 12 hours.

Sleep among animals. Scientists study sleeping animals by the same methods that they study sleeping human beings. Among the *vertebrates* (animals with backbones), only reptiles, birds, and mammals experience true sleep, with changes in brain wave patterns. Most kinds of reptiles do not have dreaming sleep periods, and most kinds of birds have only very brief ones. All mammals have periods of dreaming sleep and also periods of slow-wave sleep.

Different species of reptiles, birds, and mammals have different sleep patterns. Some sleep for many short periods every day, but others sleep for one long period. Animals that are *nocturnal* (active at night) sleep during the daytime. Some mammals, such as cattle, can sleep standing up. But they dream only while lying down.

The other two groups of vertebrates—fish and amphibians—have periods of what might be called sleep. During these periods, they become less aware than at other times of what is happening around them. But scientists have found no evidence of brain wave changes that suggest sleep among such animals.

Insects, spiders, and other *invertebrates* (animals without backbones) have daily periods of reduced activity. But invertebrates do not show a sudden decrease in response to their surroundings. No brain changes have been found to occur during their rest periods.

What happens without sleep. People deprived of sleep lose energy and become quick-tempered. After two days without sleep, a person finds that lengthy concentration becomes difficult. Through pure determination, a person may perform tasks well for short periods but is easily distracted. Many mistakes are made, especially in routine tasks, and attention slips at times. Every "sleepless" person experiences periods of dozing off for a few seconds or more. The person falls completely asleep unless kept active continuously.

People who go without sleep for more than three days have great difficulty thinking, seeing, and hearing clearly. Some have periods of *hallucinations*, during which they see things that do not really exist. They also confuse daydreams with real life and often lose track of their thoughts in the middle of a sentence while speaking to someone.

Human beings have gone without sleep for up to 11 days. But people who have stayed awake so long lose contact with reality. They become suspicious and fearful

of others. For example, they may believe that a doctor is an undertaker who has come to bury them, or that the food they are eating has been poisoned.

The need for sleep. Sleep restores energy to the body, particularly to the brain and nervous system. People require both slow-wave sleep and dreaming sleep. Extra sleep of either kind does not make up for a lack of the other. Slow-wave sleep may help especially in building protein and restoring the control of the brain and nervous system over the muscles, glands, and other body systems. Dreaming sleep may be especially important for maintaining such mental activities as learning, reasoning, and emotional adjustment.

Scientists are still seeking answers to many questions about the need for sleep. They do not know, for example, why human beings cannot simply rest, as insects do. Nor have they discovered exactly how sleep restores vigour to the body.

Related articles in *World Book* include:

Baby (Sleeping conditions)	Hibernation	Nightmare
Dream	Insomnia	Sleepwalking
	Narcolepsy	Snoring

Sleeper. See **Railway** (The rails and sleepers).

Sleeping bag. See **Camping** (Sleeping bags).

Sleeping sickness is a disease that attacks the nervous system and often results in a prolonged sleep. It affects human beings and other *vertebrates* (animals with backbones) and is usually fatal if untreated. Sleeping sickness occurs only in Africa and is a serious health problem there for both humans and animals. Its effect makes livestock rearing impossible in some areas of the continent. The disease is also referred to as *African sleeping sickness* or *African trypanosomiasis*.

Cause. Sleeping sickness is caused by several species of single-celled parasites called *trypanosomes*. These organisms have a wormlike shape and a whiplike extension, called a *flagellum*, at one end. The flagellum also extends along one side of the body to form a structure called an *undulating membrane*. A trypanosome moves by waving or whipping the membrane.

The trypanosomes that cause sleeping sickness in humans have the scientific names *T. rhodesiense* and *T. gambiense*. (The *T.* stands for *Trypanosoma*.) The trypanosomes are transmitted by the tsetse fly, an insect that lives along lake shores and riverbanks in Africa. The fly becomes infected with trypanosomes while feeding on the blood of an already infected human or animal. The trypanosomes multiply in the insect's stomach, then pass to the salivary glands. A person becomes infected when bitten by an infected fly.

Sleeping sickness in livestock results from infection by other trypanosomes, including *T. brucei* and *T. congolense*. The trypanosomes are generally transmitted by tsetse flies or other biting insects. One species is transmitted by an infected animal during mating.



Sleeping sickness is caused by long wormlike parasites called *trypanosomes*.

Symptoms and diagnosis. The speed at which sleeping sickness develops in people varies with the type of trypanosome involved. In general, *T. rhodesiense* produces symptoms that progress more rapidly than those caused by *T. gambiense*. Most cases of sleeping sickness begin with fever, headache, and chills. These symptoms are followed by swelling of the lymph nodes, skin rash, and weakness. In severe cases, the trypanosomes infect the central nervous system, resulting in uncontrollable sleep, coma, and death.

Doctors diagnose sleeping sickness by examining a sample of the patient's blood, spinal fluid, or lymph. In patients who have the disease, the sample contains trypanosomes, which can be seen under a microscope. Early diagnosis of sleeping sickness is important because prompt treatment can eliminate the parasites and prevent permanent damage to nerve tissues.

Treatment and prevention. Doctors use a variety of drugs to control sleeping sickness in people. The drug suramin is commonly given in the early stages of the disease. If treatment starts before the central nervous system becomes infected, the chances for recovery are excellent. Treatment of sleeping sickness in its later stages is less successful. In addition, trypanosomes tend to develop resistance to the drugs used.

Scientists have done much work on finding methods to control sleeping sickness and its carriers. In some parts of Africa, insecticide sprays have proved effective in eliminating tsetse fly populations. Other control efforts include the use of radiation to make male tsetse flies sterile and therefore unable to reproduce. See **Tsetse fly**.

Sleeplessness. See **Insomnia**.

Sleepwalking, also called *somnambulism*, is a condition during which a partly awakened sleeper performs various physical activities. Most sleepwalkers simply sit up in bed or stand near it. Some actually walk about, but few perform more complicated actions.

Sleepwalking is more common among children than among adults. A person is most likely to sleepwalk during a period of worry or tension. Sleepwalking rarely occurs while the sleeper is dreaming. After awakening, most sleepwalkers do not recall their activities.

Most sleepwalking is harmless. But a sleepwalker may be injured by falling out a window or down stairs or by walking into an obstacle. It does not harm a sleepwalker to be awakened.

Sleet consists of transparent, solid grains of ice that are smaller than 5 millimetres in diameter. Sleet pellets are spherical or irregular in shape. They are formed by the freezing of raindrops or the refreezing of partly melted snowflakes. The raindrops or melted snowflakes fall from high altitudes in the atmosphere through a layer of below-freezing air near the earth's surface, changing into sleet. When sleet hits a hard surface, it bounces and makes a rapping sound.

A form of precipitation called *graupel* or *snow pellets* is sometimes mistaken for sleet. A graupel pellet forms when cloud droplets hit a snowflake and freeze onto it. Graupel is about the same size and shape as sleet but is white and opaque rather than transparent. In addition, graupel is soft and may disintegrate when it strikes a hard surface.

Sleigh. See **Sledge**.

Slessor, Kenneth (1901-1971), one of Australia's most important modern poets, was foremost in bringing modernity into Australian poetry after a strongly nationalistic period. He ignored the traditional Australian subjects of drovers, overlanders, and other characters. He was little concerned with Australian landscape. Slessor's most frequent theme was the sea, and his sea-poems introduced a new trend in Australian poetry. His philosophy was more modern and universal than that of earlier Australian poets.

Slessor's work falls into three groups that mark his development as a poet. His earliest poems, typified by the contents of *Earth Visitors* (1926), are works of fantasy and romance written in a style Slessor had not yet perfected.

In his second period, Slessor moved from romantic concepts to the cynical and sceptical, toward impressionistic writing and intellectualism. In the collection *Cuckooz Contrey* (1932), there is masterly control of form and a move toward themes related to sensory experience and more modern subjects. The tone is often cynical. Beneath the highly sophisticated wit and original imagery, there is a growing feeling of frustration and bitterness toward death and human vanity.

The "Captain Cook" series belongs to this period. It is a blend of realism and romance, easily and naturally presented in highly flexible verse. It also provides an example of Slessor's obsession with the symbols of time and the sea. He saw time as the sea and humankind as the sailor embarked on a voyage without hope of destination. Of the same period is "Country Towns," a realistic poem of the Australian countryside, which Slessor describes with ironical but affectionate amusement.

Slessor's third period, marked by *Five Bells* (1939), shows him in complete control of his poetic techniques and indicates his arrival at realism by way of romanticism and cynicism. This period is considered the culmination of his development. Slessor emerged as a tragic poet obsessed with death, disillusionment, and despair.

"Beach Burial" is considered the finest of modern war poems in the English language. It is a reflection on perplexity in the face of the futility of war. It has faultless structure and powerful, perceptive communication of the poet's experience. This poem, together with "Sleep," "South Country," and "Five Bells," marks the climax of Slessor's talent.

Slessor was born at Orange in New South Wales and was educated in Sydney. He worked as a journalist and as an editor before becoming a war correspondent during World War II (1939-1945).

Slessor, Mary (1848-1915), a Scottish missionary, spent most of her life working on the Calabar coast of Nigeria, in Africa. As a result of her devoted work on behalf of the local people, the United Kingdom government made her a magistrate in 1905. Mary Slessor was born at Aberdeen and worked in a factory until 1875, when she volunteered for missionary work.

Slide. See **Bacteriology** (Studying bacteria).

Slide, in photography. See **Photography** (Developing colour film); **Projector**.

Slieve Bloom is a range of mountains in Ireland. It is located in the northwestern part of the province of Leinster, and the border between the counties Laois and Offaly runs along the mountain ridge. Slieve Bloom is

made up largely of Old Red sandstone. Its highest peak, Arderin, rises to 528 metres above sea level.

Slieve Donard is the highest peak in the Mourne Mountains in Down, in Northern Ireland. It rises 852 metres above sea level. On clear days, views of the Donegal Mountains to the west, the Wicklow Mountains to the south, and the Isle of Man in the Irish Sea may be had from its summit. Slieve Donard is named after a saint of the A.D. 400's.

Sligo is a county in the province of Connacht in the northwest of the Republic of Ireland. It is famous for its association with the writer William Butler Yeats and for its scenery. A third of the population of the county lives in Sligo town and others commute to work there. The remainder of the county is mainly agricultural.

People and government. The population of Sligo has been in decline since the mid-1800's, except for a short period during the 1970's.

About 93 per cent of the people of Sligo are Roman Catholic. Most of those of other religions are members of the Church of Ireland.

The counties of Sligo and Leitrim form one constituency which elects four members to *Dáil Éireann* (the lower house of the Republic of Ireland's parliament). A county council based in Sligo town is in charge of local government administration.

Economy. One-fifth of people in Sligo work in agriculture. Farms are generally small, averaging 15 hectares. The land is not suited to arable crops, and most farmers raise beef or dairy cattle.

Manufacturing accounts for one-sixth of employment. Much of it is in the town of Sligo, with Tubbercurry as a secondary centre.

More than half of the people work in various service industries. These include education, health, and transport. Tourism is of major importance to the town and other coastal areas.

Major roads radiate from Sligo town to Dublin (N4), Galway (N17), Ballina (N59), Donegal (N15) and Enniskillen (N16). There is a railway from Sligo to Dublin. Sligo is a small seaport and has an airport.

Land. The Atlantic Ocean forms Sligo's border to the



Sligo is a coastal county in the northwest of the Republic of Ireland, in the province of Connacht.

Facts in brief about Sligo

Population: 1991 census—54,736.

Area: 1,796 km².

Largest towns: Sligo, Tubbercurry, Ballymote, Collooney.

Chief products: *Agriculture*—cattle, milk, sheep, timber.

Manufacturing—building materials, clothing, engineering goods, food products, medical supplies, timber products.

Origin of name: From the Irish *Sligeach* (shelly place or river).

north and northwest. Leitrim is to the northeast, Roscommon to the southeast and Mayo to the southwest.

In the north a plateau extends across the county boundary. Mountains include the steep-sided Ben Bulbin and the isolated Knocknarea. Lough Gill and Glencar Lake lie between the hills. To the north and west there is a coastal plain, with many sandy beaches. The Ox Mountains are in the west.

The River Moy and the River Owenmore drain the lowland to the south. In the southeast the land rises towards the Bricklieve and Curlew Mountains. Between them is Lough Arrow. Peat bog areas are found in the uplands and in poorly drained places in the lowland.

The annual rainfall is less than 120 centimetres on the lowland, but higher on the uplands. The average temperatures are 5°C in January and 15°C in July.

History. Sligo has a greater density of prehistoric monuments than any other Irish county. Most remarkable is the collection of stones to the west of Sligo town at Carrowmore. These stones make up one of the largest groups of Stone and Bronze Age remains in Europe. Nearby is a prehistoric cairn on Knocknarea, which is the legendary burial place of Queen Maeve.

Sligo town was an Anglo-Norman outpost, where the Earl of Kildare, Maurice Fitzgerald, built a castle and monastery in the 1200s. The de Burgos, an Anglo-Norman family, were the main power in the county at that time. With the revival of Irish control, the ruling families were the O'Connors, O'Haras, and O'Dowds. Sligo town developed as a major market centre. The

county suffered severely during the Great Famine of the 1840s, losing a third of the population through death and emigration.

Sligo is known internationally in English literature through the writings of William Butler Yeats. He spent much time in Sligo, and he was inspired by its landscapes and folklore. Northern Sligo is known as *Yeats Country* and hosts an annual Yeats Summer School. Yeats is buried at Drumcliffe, beneath Ben Bulbin (see *Yeats, William Butler*).

Sligo (pop. 17,285) is the county town of the county of Sligo in western Ireland. It is the second largest town in the province of Connacht. The town lies on a plain by the River Garavogue, between Lough Gill and the sea. Sligo has an airport and a good harbour.

Sligo has a number of industries, including fishing, making dies and tools, and meat processing. Other local products include clocks, hospital supplies, scales, videotapes, and women's clothing.

Slim, William (1891-1970), was a British army commander in World War II (1939-1945). He fought in Sudan, Syria, Iran, and Iraq and then took command of United Kingdom forces in Burma. These forces were disheartened because of repeated defeats by the Japanese, but Slim restored morale, reorganized his army, and led it to victory.

Slim was born in Bristol, England. During World War I (1914-1918), he fought in France, Gallipoli, and Mesopotamia. From 1953 to 1960, he served as governor general of Australia. Slim became a viscount in 1960.

Slime mould is a tiny, simple fungus that usually grows on decaying wood and moist soil. Slime moulds traditionally have been classified in both the animal and plant kingdoms. Today, however, many biologists classify them in the kingdom Fungi.

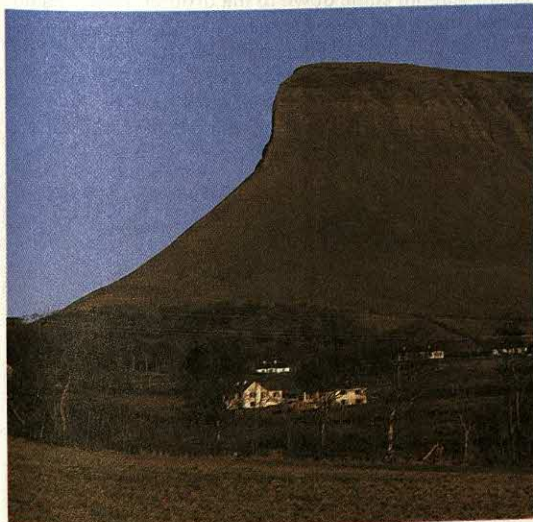
Like most fungi, slime moulds reproduce by means of *spores* (tiny sex cells). The spores are distributed by the wind. Then they germinate and form a simple cell with a single, hairlike attachment called the *flagellum*. With this attachment, the organism swims about. Later, it loses the attachment and several cells unite in a jellylike mass which has the power of slow, creeping movement. This mass, called the *plasmodium*, is sometimes 30 centimetres wide. It forms the vegetable body of slime moulds. Finally, the plasmodium develops into masses of mould-like spores. These masses are often found on the stumps and bark of trees, varying in colour from white to orange and red.

Scientific classification. Slime moulds belong to the division Myxomycota in the kingdom Fungi.

Sling is one of the most ancient of weapons. It was probably the first weapon designed to hurl a stone with more force than a man could deliver with the hand and arm. In its oldest form, the sling is a leather or hide strap, with a string fastened to each end. A stone or other object is placed on the strap, and the operator holds the two cords. The operator whirls the sling above the head, and then lets go of one end of the cord to hurl the stone.

Slings are mentioned many times in the Bible. A most familiar reference is to the slaying of Goliath by David with a stone (I Sam. 17: 49-50).

The ancient people of the Balearic Islands in the Mediterranean Sea became famous for their skill with the



Ben Bulbin is a flat-topped, steep-sided mountain in County Sligo. It figures in the legend of Diarmid and Gráinne.

sling. The sling was of great use to the armies of Egypt, Greece, and Rome. During the Middle Ages, soldiers used slings attached to a staff. They hurled big stones against fortifications.

A small hand catapult is sometimes called a *sling-shot*, or *sling*. It is made by fastening an elastic band on each prong of a forked stick, and connecting the elastics by a leather pouch.

The pouch holds a stone or small metal bullet. The fork is held in one hand, and the elastics are stretched by pulling the pouch with the other hand. The shot is hurled when the pouch is released.

Bolas are weapons used on the pampas of South American countries and by the Eskimos. Bolas are made of stones or balls of clay that are fastened to the ends of rope or cowhide. The free ends are tied or braided together and form a handle. The thrower hurls the bola at an animal. The stones or balls wind the ropes around the animal's legs and throw it to the ground.

See Also **Indian, American** (picture: Swinging their bolas).

Slip. See **Ceramics** (Making ceramics); **Pottery** (Shaping the clay).

Slipperwort is the name of several evergreen plants whose blossoms are shaped somewhat like slippers. They are native to Central and South America, but are grown in greenhouses and gardens in temperate parts of the world. Alpine species are grown in rock gardens. Slipperworts have many flowers. Popular species of the plant include the *common* slipperwort, with spotted yellow flowers, the *bush* slipperwort, which has small yellow flowers, and the *violet-flowered* slipperwort.



Common slipperwort

Scientific classification.

Slipperworts belong to the figwort family, Scrophulariaceae. The common slipperwort is classified as *Calceolaria crenatiflora*. The bush slipperwort is *C. integrifolia*. The violet-flowered slipperwort is *C. purpurea*.

Sloane, Sir Hans (1660-1753), was an Irish-born doctor and botanist. His private collections and library provided the beginning of the British Museum. Throughout his life, Sloane collected plants. The plants that he gathered in Jamaica in 1687 and 1688 were the first brought to Britain from the West Indies. Sloane succeeded Sir Isaac Newton as president of the Royal Society. Sloane was born at Killyleagh, County Down. He became a baronet in 1716.

Sloe, also called *blackthorn*, is a spiny, branching shrub related to the plum. It grows in Europe, Central Asia, and the eastern part of North America. It bears



Roman sling

white blossoms and small black fruit. The fruit are less than 13 millimetres in diameter and are used to make wine, jam, pickle, and dyes. Sloe gin is a pink liquor that is coloured and flavoured with sloe. People use sloe branches to make canes and tool handles.

Scientific classification. Sloe is in the rose family, Rosaceae. It is *Prunus spinosa*.

See **Blackthorn**.

Sloop. See **Sailing** (Kinds of sailing boats; pictures.)

Slope mine. See **Coal** (Underground mining; diagram: Kinds of underground mines).

Slot machine is a device that works when a coin is dropped into a special slot. The coin sets the mechanism of the machine in motion. There are many types of slot machines. *Vending machines* sell a variety of products, including food items such as chocolate and snacks. Some vending machines dispense liquids such as hot coffee or tea. *Juke boxes* are slot machines that play music on gramophone records.

Another slot machine is a gambling device. It is sometimes called a *one-armed bandit*. A player drops a coin into a slot and pulls a lever on the side of the machine. A group of reels spin. When they stop, a combination of pictures shows in a window. The combination determines whether a player wins or loses the coin. One-armed bandits are illegal in some places.

Sloth is the common name of a family of South American animals which have a slow and peculiar way of moving about. When moving in the trees, they walk upside down, hanging from branches. Sloths can hang so securely from the branches with their hooklike claws that they even fall asleep in this position. A sloth may even stay suspended in the trees for some time after it dies.

These strange animals have an odd appearance. They have almost no tails or ears, and their noses are blunt. They have peglike teeth. Their hair is long and coarse. In some species, it is greyish in colour, which makes them hard to see among the branches. A sloth asleep looks much like the stump of a bough, especially when it has a growth of green algae on its hair, as many sloths do. Sloths seldom come down to the ground. They feed on leaves, buds, and young twigs.

Sloths are abundant in some tropical rainforests. They need relatively little food and have a lower rate of *metabolism* than do other mammals of about the same size. Metabolism is the process by which living things turn food into energy.



The sloth uses its claws to hang from branches.

There are two main species. One, called the *unau*, has two toes on the front feet. The other, called the *ai*, has three toes on the front feet.

Scientific classification. The sloth makes up the sloth family, *Bradypodidae*. The common two-toed sloth is *Choloepus didactylus*. The common three-toed sloth is *Bradypus tridactylus*.

See also **Animal** (picture: Animals of the tropical forests); **Ground sloth**.

Sloth bear is a big, shaggy animal with a mane of fur around its neck and shoulders. It is also called a *honey bear* because honey is one of its favourite foods. Sloth bears live in the rocky canyons and hills of India and Sri Lanka. They have a short temper and can be dangerous.

The sloth bear is about 1.5 metres long and weighs up to 115 kilograms. It has long black fur with a light-coloured U-, V-, or Y-shaped patch on the chest. The sloth bear's face is grey and almost hairless.

Sloth bears usually eat termites and the *larvae* (grubs) of bees. They also eat flowers, leaves, fruit, and grain. They will climb anywhere to get at nests of termites or bees. They use their big feet and long claws to rip open



The sloth bear has shaggy black fur and a grey, almost hairless face. These bears live in the hills of India and Sri Lanka.

termite nests and open tree trunks and branches that hold honeycombs. At a termite nest, they blow away the dust to expose the termites and then suck the insects into their mouths. The sloth bear's lips, tongue, and teeth are well suited to its feeding habits. It has a long snout, flexible lips, and a long sticky tongue. It lacks two front teeth in both the upper jaw and lower jaw. The bear draws in its food through this cavity.

Sloth bears hunt for food at night. During the day they sleep in protected places, usually in caves along riverbanks. They do not sleep for long periods in the winter as some other bears do.

Most female sloth bears give birth to one or two *cubs* (young bears) at a time. The cubs often ride on their mother's back, even when she climbs trees.

Scientific classification. Sloth bears belong to the bear family, *Ursidae*. They make up the genus *Melursus* and are species *M. ursinus*.

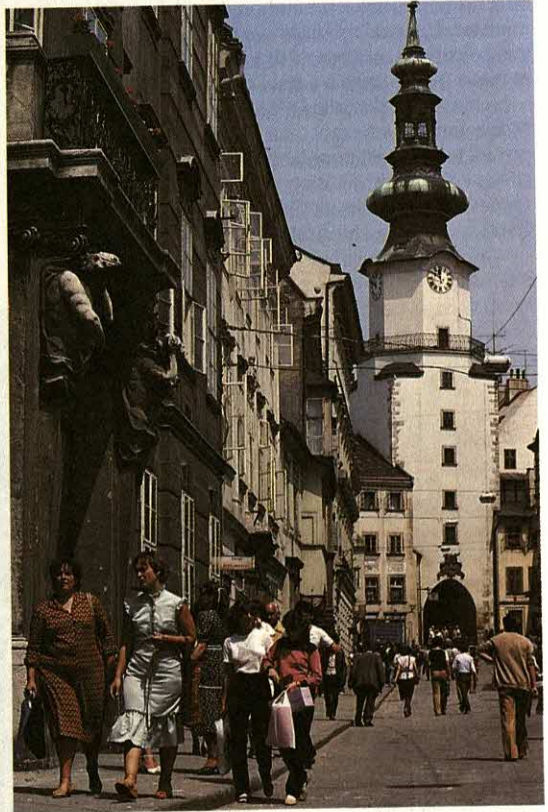
Slouch hats were universally adopted for the Australian Commonwealth forces in 1903. They were turned up at the left with the General Service badge, which featured the rising sun. The hats are not uniquely Austra-

lian, but their wide use by Australian forces in both world wars led them to become a national symbol. The hat was first introduced into the Australian forces in 1885 by Colonel Tom Price for wear by the Victorian Mounted Rifles. The brim was looped up at the right side to enable troops to "look the inspecting officer straight in the eye when marching past."

Slough (pop. 98,600) is a borough and local government district in Berkshire, England. The industrial town of Slough lies about 29 kilometres west of London. The Slough Trading Estate was established in 1920. Light industries on the estate produce various products, including electronic components and processed food. Many people who live in Slough work in London.

Slovakia is a country in central Europe that became independent on Jan. 1, 1993. It is bordered by Poland to the north, Ukraine to the east, Hungary to the south, and Austria and the Czech Republic to the west. From 1918 until Dec. 31, 1992, Slovakia and the Czech Republic were partners in the larger nation of Czechoslovakia. A Communist government took over and ruled Czechoslovakia from 1948 to 1989.

Bratislava is Slovakia's capital and largest city. A Slavic people called Slovaks make up most of the country's population. About 600,000 Hungarians also live in Slovakia. For Slovakia's total population, see the *Facts in brief* table with this article.



Bratislava, Slovakia's capital, is a major cultural and manufacturing centre. The old section of the city, above, has many churches and other buildings from the 1300's and 1400's.

Facts in brief about Slovakia

Capital: Bratislava.**Official language:** Slovak.**Official name:** Slovenská Republika (Slovak Republic).**Area:** 49,035 km². *Greatest distances*—east-west, 418 km; north-south, 209 km.**Elevation:** *Highest*—Gerlachovský štít, 2,655 m above sea level. *Lowest*—94 m above sea level, near the Bodrog River on the Hungarian border.**Population:** *Estimated 1996 population*—5,381,000; density, 109 people per km². *1991 census*—5,268,935. *Estimated 2001 population*—5,519,000.**Chief products:** *Agriculture*—barley, livestock, maize, potatoes, sugar beet, wheat. *Manufacturing*—ceramics, chemical products, machinery, petroleum products, steel, weapons.*Mining*—coal.**National anthem:** 'Nad Tatrou sa blýska' ('Lightning Flashes over the Tatra').**Money:** *Currency unit*—Slovak koruna. One koruna = 100 halier.

Government

Slovakia is a parliamentary democracy. A one-house parliament, called the National Council, makes the country's laws. Voters elect the 150 members to four-year terms. A president serves as head of state. The parliament elects the president to a five-year term. The president appoints a prime minister, who serves as head of government. The prime minister is usually the head of the party with the most seats in parliament. The president also appoints a cabinet on the advice of the prime minister. The cabinet helps the prime minister carry out the executive functions of the government. The prime minister has executive authority in the government.

Numerous political parties are active in Slovakia. The Movement for a Democratic Slovakia, a left-of-centre group, is the most popular political party. The second strongest party is the Party of the Democratic Left, the successor to the Slovak Communist Party. The Supreme Court is Slovakia's highest court.

About 50,000 soldiers make up Slovakia's armed services. Men are required to serve for 12 months after reaching the age of 18. Women enlist voluntarily.

People

Ethnic groups and languages. Slovaks make up the majority of Slovakia's population. People of Hungarian descent form the second largest group. Smaller numbers of Czechs, Germans, Gypsies, Poles, Russians, and Ukrainians also live in Slovakia.

Slovak is Slovakia's official language. Czech, German, Hungarian, and Polish are also spoken. The Gypsies speak Romany, which belongs to the Indo-Iranian group of languages. Since the end of Communist rule in 1989, tensions have surfaced between Slovaks and the Hungarian minority over language and cultural issues.

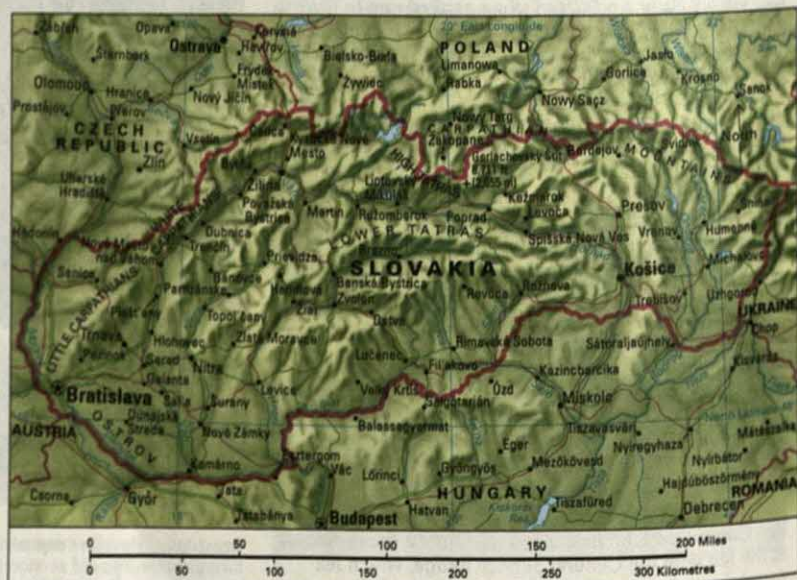
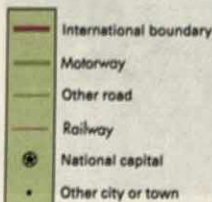
Way of life. Most of Slovakia's people live in towns and cities. The largest cities are, in order of size, Bratislava, Košice, Trnava, Nitra, Prešov, and Žilina. Slovakia has a shortage of housing. Many urban residents live in high-rise apartments. Most rural families live in single-family houses. The standard of living is higher in Slovakia than it is in many other formerly Communist countries in Europe. Most families own cars, refrigerators, televisions, and washing machines. Many city families have weekend cottages in the country.

The lifting of political controls and the opening of borders after the end of Communist rule have caused an increase in crime and drug abuse. Air and water pollution are serious in many parts of the country.

Food and drink. *Bryndzové halušky* (noodles with sheep's cheese) is a typical Slovak dish. Hungarian food, including a spicy stew called *goulash* and other paprika-flavoured dishes, is also popular. Wine is the most common alcoholic beverage. A plum brandy called *slivovica* is also popular.

Recreation. Slovakia's people enjoy a variety of leisure activities. Many people attend soccer matches and

Slovakia





A worker assembles a tractor in a factory in Martin. Manufacturing is important to the economy of Slovakia. About one-third of the country's workers hold jobs in factories.

other sporting events. Skiing is also popular. City residents often spend their evenings socializing with friends in wine cellars or attending ballets, concerts, operas, or plays. Many families enjoy camping, hiking, and mountain climbing.

Religion. Most people in Slovakia are Roman Catholics. The Orthodox Church and most Protestant denominations are also active. The country has a small Jewish population. Most of Slovakia's Jews were killed by the Nazis during World War II (1939-1945).

Education. Almost all adults in Slovakia can read and write. Children are required to attend eight years of primary school and two years of secondary school. Comenius University in Bratislava is Slovakia's leading university. Košice and Trnava also have universities.

Arts. Folk art has a long tradition in Slovakia. The best-known objects made by folk artists are baskets, glass paintings, pottery, and woodcarvings. Painted wooden houses and other forms of folk architecture are found in many regions, including the Ukrainian villages of eastern Slovakia.

Land and climate

A series of mountain ranges, part of the western branch of the Carpathian Mountains, covers most of Slovakia. The Little Carpathians and the White Carpathians dominate much of western and northwestern Slovakia. A range called the High Tatras extends along part of the country's northern border. Gerlachovský štít, Slovakia's highest peak, rises to 2,655 metres in this range. The great beauty of the range has made it a favourite holiday spot. The area is also a national park.

The Danubian Lowlands make up southwestern Slovakia. The Danube River forms the southern boundary of this region. The lowlands are a fertile farming region.

Several rivers wind through Slovakia, including the Danube, the Hornád, the Hron, and the Váh. Firs and spruces cover many of the country's mountains. Beeches, birches, lindens, and oaks grow in lower areas.

Temperatures in Slovakia range from a low of -10°C

in January to a high of 20°C in July. Slovakia receives from 60 to 100 centimetres of rain, snow, and other forms of moisture annually.

Economy

Slovakia, which had been an agricultural region for most of its history, became industrialized under Communist rule. Czechoslovakia's Communist government centralized the economy after it came to power in 1948, taking control of almost all the country's land and businesses. It emphasized heavy industry, such as the manufacture of machinery and steel. Slovakia became the centre of Czechoslovakia's weapons industry. Other industries that developed in Slovakia were ceramics, footwear, petroleum refining, timber, and textiles.

After the Communist government left office, Czechoslovakia's new leaders began to take steps toward establishing an economy based on free enterprise. In a free enterprise economy, businesses operate without extensive government control. Many private businesses were established in Slovakia. Most of them were in construction, manufacturing, and retail trade and other service industries. Additionally, many state-owned businesses became privately owned. Today, about 65 per cent of all businesses in Slovakia are privately owned. However, the economic changes produced hardship in Slovakia, including rising unemployment.

Service industries and manufacturing are the mainstays of Slovakia's economy. Service industries employ about 44 per cent of the country's workers.

About 33 per cent of Slovakia's work force holds jobs in manufacturing. Slovakia's main manufactured products include ceramics, chemical products, machinery, petroleum products, steel, and weapons. Bratislava and Košice are the country's main industrial centres. The weapons industry is concentrated in Martin.

Agriculture employs about 12 per cent of the workers of Slovakia. Barley, maize, potatoes, sugar beet, and wheat are Slovakia's primary crops. Wine grapes are grown on the southern slopes of the High and Low Tatras, and in southern Slovakia. Fruit and tobacco grow in the Váh River Valley. Slovak farmers also rear livestock, including cattle, pigs, and sheep.

Mining and energy. Slovakia's main mineral resources are copper, iron, lead, manganese, and zinc. Hydroelectric plants are an important source of energy in Slovakia. There are hydroelectric plants on the Danube, Hornád, Orava, Slaná, and Váh rivers.

Trade. Slovakia's main exports include chemical products, petroleum products, steel, and weapons. Crude oil, natural gas, and electronic products are the main imports. Austria, the Czech Republic, Germany, Hungary, Poland, and Russia are Slovakia's main trading partners.

Transportation and communication. Slovakia has about 18,300 kilometres of roads. Railways link all the major cities and many smaller towns. Bratislava has an international airport.

Slovakia has about 20 daily newspapers and about 570 magazines and journals. Television is state-owned.

History

Early days. Slavic tribes settled near the Danube River in what is now Slovakia in the A.D. 400's and 500's.

In 623, Slovakia became part of an empire founded by Samo, a former merchant of a Germanic people known as the Franks. In the 800's, Slovakia became part of the Greater Moravian Empire established by a ruler named Mojmir. The empire also included Bohemia and Moravia, two main regions in what is now the Czech Republic. Hungarian tribes conquered the empire in 907. Hungary then ruled Slovakia for nearly 1,000 years.

Hungarian rule. A period of religious wars began in Bohemia and Moravia in the 1400's. Many Czech nobles fled Bohemia and Moravia and settled in Slovakia. From 1438 to 1453, a Czech noble controlled much of southern Slovakia. The Ottomans defeated Hungary in the Battle of Mohács in 1526 and occupied central and eastern Hungary soon afterward. Slovakia became the cultural and political centre of what remained of Hungary.

During Hungarian rule, the Slovaks were pressured to give up their culture and language and become Hungarian. Beginning in the late 1700's, Slovak religious leaders tried to create a sense of national identity among Slovaks. Anton Bernolák, a Roman Catholic priest, developed a Slovak literary language based on western Slovak dialects. Jan Kollár and Pavol Šafařík, two Slovak Protestants, developed a form of the Slovak language that combined Czech and Slovak dialects. But Hungarian control prevented the growth of a large nationalist movement among Slovaks. In 1867, Austria and Hungary formed a monarchy called Austria-Hungary.

At the end of World War I (1914-1918), Austria-Hungary collapsed, and the Czechs and Slovaks united to form the new nation of Czechoslovakia. The Czechs dominated Czechoslovakia's economy and government and many Slovaks grew dissatisfied with Czech control, and support for extreme nationalist movements grew.

World War II. In 1938, Hungary forced Czechoslovakia to give up several areas with large Hungarian populations, including the city of Košice. These areas were along the border of Slovakia and Hungary. On March 14, 1939, faced with the threat of being divided between Germany, Poland, and Hungary, Slovakia declared its independence. Jozef Tiso, a Roman Catholic priest, was elected president. German troops occupied Czechoslovakia the following day, and Slovakia came under German influence. In September, World War II broke out. In 1944, several Slovak resistance groups fought against German control in the Slovak National Uprising.

Communist rule. At the end of the war in 1945, Slovakia once again became part of Czechoslovakia. Tiso was convicted of treason and cooperating with the Germans. From 1945 until 1948, Communists and members of other political parties ruled Czechoslovakia in a coalition government. In February 1948, the Communists staged a political crisis and took over the government.

In the late 1960's, many Slovak Communist Party leaders and intellectuals took part in a movement to reform the Communist system. The movement was led by Alexander Dubček, a Slovak who became head of the Czechoslovak Communist Party in January 1968. But troops led by the Soviet Union invaded Czechoslovakia on Aug. 21, 1968. Gustáv Husák, another Slovak, replaced Dubček as head of the Czechoslovak Communist Party in April 1969.

In November 1989, Czechs and Slovaks called for changes in the government and greater political, eco-

nom, and civil freedoms. Less than a month later, Czechoslovakia's Communist government resigned, and non-Communists gained control of the government. The first free elections since 1946 were held in June 1990. In the elections, non-Communists won a majority of seats in the legislature.

In parliamentary elections held in June 1992, the Movement for a Democratic Slovakia, a left-of-centre party led by Vladimír Mečiar, won a majority of seats in Slovakia's parliament. Václav Klaus's Civic Democratic Party, a centre-right group, won a majority of seats in the parliament of the Czech Republic. On Jan. 1, 1993, Slovakia and the Czech Republic were formed to replace Czechoslovakia. In February, Slovakia's parliament elected Michal Kováč president of the new nation.

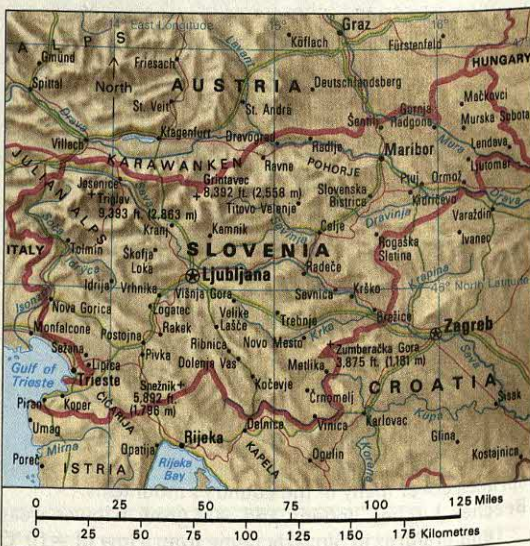
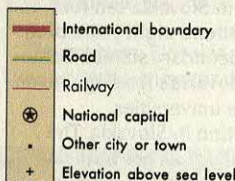
In March 1994, Mečiar was deposed by a no-confidence vote tabled by the president, amid accusations of financial impropriety.

Related articles. See the articles on **Czech Republic** and **Czechoslovakia** and their lists of *Related articles*. See also:
Bratislava
Carpathian Mountains
Hungary (History)
Košice

Slovaks are a Slavic people who make up most of the population of Slovakia. The ancestors of the Slovaks settled in what is now Slovakia by the A.D. 400's.

In the 800's, the Slovaks were part of the Greater Moravian Empire. The *Magyars* (Hungarians) conquered Slovakia about 900 and ruled the Slovaks for the next 10 centuries. Under Hungarian rule, the Slovaks preserved their own language, but they did not view themselves as a separate people until the 1800's.

Slovenia





Slovenia is a mountainous country in central Europe. Small rural villages dot its countryside.

The Hungarians tried to destroy the new Slovak nationalism, and many Slovaks emigrated to the United States. Others worked with another Slavic group, the Czechs, toward the formation of an independent state. The republic of Czechoslovakia was founded in 1918. Most Slovaks had little or no political experience, and the Czechs took control of the new nation. The Slovaks did not gain equal representation in the government until the 1960s. In 1992, Czechoslovakia ceased to exist and the two independent countries of the Czech Republic and Slovakia were created in its place.

See also **Slovakia** (People).

Slovenia is a small, mountainous country in central Europe that declared its independence in 1991. In 1918, Slovenia became part of the Kingdom of the Serbs, Croats, and Slovenes, later renamed Yugoslavia. In 1946, Yugoslavia became a federal state consisting of six republics, one of which was Slovenia.

Slovenia covers 20,251 square kilometres. For Slovenia's total population, see the *Facts in brief* table with this article. Ljubljana, Slovenia's capital and largest city, is the centre of cultural and political life in the nation. It has about 276,000 people. Two other important cities in Slovenia are Maribor in the northeast and the port city of Koper.

Slovenes make up almost all of Slovenia's population. Most other residents are Croats, Serbs, or Hungarians. A small number of Italians, as well as members of other nationalities, also live in Slovenia.

Tourists visit Slovenia throughout the year. The mountains have ski resorts and beautiful lakes, and the short coastline has sunny beaches that attract many holidaymakers. Tourists also go to see the caves at Postojna, near Ljubljana, which are the largest caverns in Europe. Another tourist attraction is the village of Lipica, near the Italian border in southwestern Slovenia. For more than 400 years, Lipizzaner horses have been reared at a

farm in this village for the Spanish Riding School of Vienna, Austria.

From 1945 to 1990, Communists held a monopoly on power in all of Yugoslavia, including Slovenia. In 1990, Slovenia held elections in which non-Communists won a majority of seats. The republic declared its independence in 1991.

Government. A one-house National Assembly makes Slovenia's laws. The voters elect the 90 members of the assembly to four-year terms. The government also has a 40-member Council of State, which has no legislative authority but may propose laws or ask the assembly to reconsider a vote. Council members serve five-year terms. The assembly elects a prime minister to head the government. The prime minister serves a four-year term. The voters elect a president to a five-year term, but the office is largely ceremonial. All citizens 18 years old or older can vote.

Slovenia adopted its first constitution as an independent state in December 1991. The Constitution guarantees freedom of speech, assembly, press, and religion.

The most important political parties in Slovenia are the Liberal Democratic Party, the Slovenian Christian Democrats, the Associated List (a coalition of four parties), the Slovenian National Party, and the Slovenian Peoples Party.

The highest court in Slovenia is the Supreme Court. The Assembly appoints all judges in Slovenia.

About 15,000 men and women make up Slovenia's armed forces. The government *conscrip*s (calls up) men at age 18 for seven months of military service, but is required to release them when there is no national emergency.

People. About 90 per cent of the people of Slovenia are Slovenes, a Slavic people who speak Slovenian. Slovenian is written in the Roman alphabet, not the Cyrillic system of writing used for many Slavic languages. Most Slovenes also speak another language, commonly German, Italian, Serbo-Croatian, or English. Most Slovenes are Roman Catholics, although some belong to Protestant churches.

About half of the people live in rural areas. Rural families usually live in single-family homes with steep roofs.

Facts in brief about Slovenia

Capital: Ljubljana.

Official language: Slovenian.

Official name: Republika Slovenija (Republic of Slovenia).

Area: 20,296 km². *Greatest distances*—north-south, 160 km; east-west, 250 km.

Elevation: *Highest*—Mount Triglav, 2,863 m above sea level. *Lowest*—sea level along the coast.

Population: *Estimated 1996 population*—2,016,000; density, 98 people per km²; distribution, 49 per cent urban, 51 per cent rural. *Estimated 2001 population*—2,046,000.

Chief products: *Agriculture*—apples, cattle, cherries, maize, pears, pigs, plums, potatoes, sheep, sugar beet, wheat. *Manufacturing*—cars, chemicals, metal goods, textiles. *Mining*—coal, lead, mercury.

Flag: The flag has horizontal stripes of white, blue, and red. The national shield is on the white and blue stripes in the upper left corner. See **Flag** (picture: Flags of Europe).

National anthem: "Zdravljica" ("The Toast").

Money: *Currency unit*—tolar. One tolar = 100 stotin.



Workers inspect electronic circuit boards in a factory near Ljubljana, Slovenia's chief manufacturing centre.

Many city dwellers live in high-rise apartment buildings. Slovenian cooking resembles that of Austria. Veal and pork are favourite meats. One of the best-known Slovenian dishes is *Ljubljana veal cutlet*, breaded slices of veal served with a cheese sauce. Slovenia produces some excellent wines.

Nearly all adults in Slovenia can read and write. Children are required to attend eight years of primary school and four years of secondary school. Slovenia has two universities and many other institutions of higher education.

Slovenia has produced many fine writers. Primož Trubar is considered the father of Slovenian literature. He wrote several religious works and translated the New Testament into Slovenian during the 1500's. France Prešeren was an important lyric poet of the 1800's. Ivan Cankar ranks among the best Slavic short-story writers of the early 1900's. Important writers of the late 1900's include Andrej Hieng, Drago Jančar, Ciril Kosmač, Tomas Salamun, and Rudi Šeligo.

Festivals play an important part in Slovenian life. Every February, the town of Ptuj in northeastern Slovenia holds a *Kurenti festival*, a celebration that dates from the pre-Christian era. During the festival, people dress up in animal masks and furs and perform rituals.

Land and climate. Mountains make up much of Slovenia, and thick forests cover about half the land. The Julian Alps lie in Slovenia's northwest corner. Mount Triglav, the highest point in Slovenia, rises 2,863 metres in this range. The mountains are home to many types of game animals, such as small antelopes called *chamois*. Hilly plains spread across the central and eastern parts of Slovenia. The central part of the country also includes a limestone region called the *karst*. The karst is characterized by caves and underground channels that cause rainwater and even lakes to appear and disappear. Slovenia has a short coastline along the Adriatic Sea.

Slovenia's climate varies greatly from region to region. The mountains have exceptionally cold winters with much snow. Heavy rains fall in early summer. Sum-

mers are warm in the mountain valleys but cooler at higher elevations. The coastline has a mild climate. The temperature rarely falls below freezing in winter, and summers are hot and dry.

Northeastern Slovenia has cold winters and hot summers. Temperatures can get as high as 38 °C in the summer and frequently fall below freezing in the winter.

Economy. When Slovenia was part of Yugoslavia, it had the strongest economy of the six republics. But Slovenia's economy lagged under Communism, especially during the 1980's. After non-Communists came to power in 1990, Slovenia began to establish a free-enterprise system.

About 46 per cent of the workers in Slovenia work in service industries. Another 46 per cent work in manufacturing, and 8 per cent work in agriculture.

The leading manufactured products in Slovenia include cars, chemicals, metal goods, and textiles. The most important crops are maize, potatoes, and wheat. The major fruit grown in Slovenia are apples, cherries, pears, and plums. Farmers also rear cattle, pigs, and sheep. Slovenian mines yield coal, lead, and mercury. Major trading partners are Austria, Germany, and Italy.

Slovenia has many good roads, especially those linking it with Austria and Italy. Railways serve the main cities and towns in Slovenia. Ljubljana has an international airport. Koper is Slovenia's only commercial port.

History. During the A.D. 500's, a people called the Lombards lived in present-day Slovenia. At that time, the Lombards left Slovenia and resettled in Italy. During the late 500's, the Slovenes, the westernmost branch of a people known as the *South Slavs*, settled in Slovenia.

The Slovenes were ruled by a people called the Avars until 623. That year, Samo, a former merchant of a Germanic people known as the Franks, drove out the Avars and established an independent Slovenian state. In 748, the Slovenes came under Bavarian-Frankish rule. In 1278, the Habsburgs (also spelled Hapsburgs), an Austrian royal family, gained control of Slovenia. Slovenia remained under Austrian rule until 1918, except for a period of French control that lasted from 1809 to 1815.

After World War I ended in 1918, Slovenia became part of a new state called the Kingdom of the Serbs, Croats, and Slovenes. The name of the country was changed to Yugoslavia in 1929. In 1941, during World War II, Germany and Italy conquered Slovenia and divided it among themselves and Hungary. After the war ended, the Communists came to power in Yugoslavia, and Slovenia became one of the country's six republics.

During the late 1960's and early 1970's, some Slovenes called for the republic to *secede* (withdraw) from Yugoslavia. But in 1972 and 1973, Yugoslav president Josip Broz Tito eliminated the liberals from the Slovenian Communist Party. With this move, Tito tried to secure Slovenia more tightly to Yugoslavia.

In 1990—as Communism collapsed throughout eastern Europe—the Communists voted to end their monopoly on power in Yugoslavia. Numerous non-Communist political parties began to form. In April 1990, Slovenia held multiparty elections, and a loose coalition of non-Communist parties called DEMOS won. Lojze Peterle, a Christian Democrat, was elected prime minister. By late 1991, the DEMOS coalition had fallen apart.

In June 1991, Slovenia and another Yugoslav republic,

Croatia, declared their independence. The Yugoslav government strongly opposed the declaration. Some fighting took place between the Slovene militia and the Yugoslav military. In December, Slovenia's Assembly approved a new constitution.

In late 1991, the Yugoslav republic of Macedonia declared its independence. The republic of Bosnia-Herzegovina did so early in 1992. In April 1992, Serbia and Montenegro established a new state called Yugoslavia. Also in April, Peterle resigned after receiving a vote of no confidence from the Slovene Assembly. Janez Drnovsek, head of the Liberal Democratic Party (LDP), was elected prime minister. Elections in December 1992 resulted in a coalition government with the LDP as the strongest party. President Milan Kucan was re-elected for a five-year term.

See also **Yugoslavia (History)**.

Slovo, Joe (1926-1995), was a South African politician. He played an important part in the struggle that led to democracy in South Africa. He was chairman of the South African Communist Party (SACP) and a member of the executive committee of the African National Congress (ANC). When Nelson Mandela became president in 1994, he appointed Slovo minister of housing.

Slovo studied law at the University of Witwatersrand. In 1942, he joined the SACP. Because of his activities in support of the ANC's fight against *apartheid* (enforced racial segregation), Slovo was imprisoned from 1956 to 1958 and again in 1960.

Slovo had to leave South Africa in 1963, and he lived in exile in England, Angola, Mozambique, and Zambia. In 1985, he became chief of staff of Umkhonto We Sizwe, the military wing of the ANC. He also became the first white member of the executive committee of the ANC. In 1990, he returned to South Africa after President de Klerk granted him an amnesty.

Yossel Mashel "Joe" Slovo was born in Obelai, Lithuania. He went to South Africa in 1935. His family had left Lithuania to escape the persecution of Jews.

Slowworm. See **Blindworm**.



A slug is a kind of snail that moves by sliding on a thin coating of slime. The animal secretes the slime from its body.

Slug is a kind of snail. Most snails have a shell on the outside of their bodies. Some slugs have a small, flat shell on or under the skin, but most have no shell at all. Most land slugs have two pairs of *tentacles* (feelers) with

eyes on the end of the longer pair. The *great grey slug* is a pest because it has a huge appetite for plants. It is about 10 centimetres long. See also **Snail**.

Scientific classification. Most land slugs are in the family Limacidae or the family Arionidae. The great grey slug is *Limax maximus*.

Slum. See **Housing**.

Smallpox was the first disease conquered by human beings. Vaccination wiped it out. The last known cases of naturally occurring smallpox were isolated in 1977. Smallpox had been one of the world's most feared diseases. It killed hundreds of millions of people and scarred and blinded millions more.

Smallpox was caused by a virus that spread through the air. A smallpox victim expelled droplets containing the virus from the nose and mouth. Another person inhaled the droplets and became infected. In most cases, symptoms appeared in the new victim 10 to 12 days later. The person developed aches and a high fever. Two to four days later, a rash appeared on the face, spreading to other parts of the body. The rash resembled thousands of small pimples. During the next week, the pimples filled with pus. Scabs formed over the pimples and fell off three or four weeks later, leaving scars.

There was no treatment for smallpox. The most serious form killed about 20 per cent of its victims. Those who survived were permanently scarred, and many were blind. Survivors were immune after one attack.

During the Middle Ages, smallpox epidemics frequently swept across Asia, Africa, and Europe. In some wars, more soldiers died from smallpox than in combat. Europeans carried the disease to America, and millions of native American Indians died.

In 1796, Edward Jenner, an English doctor, developed the first vaccine to prevent smallpox. Its use quickly spread to other parts of the world. During the 1800's, many countries passed laws requiring vaccination. But the disease continued to exist almost everywhere until the 1940's, when it was eliminated in Europe and North America. However, vaccination was recommended for people travelling to or from countries where smallpox still existed.

In 1967, the World Health Organization (WHO), an agency of the United Nations, began a programme to get rid of smallpox completely. At that time, the disease infected more than 30 countries in Africa, Asia, and South America. Over 700 doctors, nurses, scientists, and other personnel from WHO joined about 200,000 health workers in the infected countries to fight the disease.

The number of smallpox-infected countries gradually decreased. The disease was found in 17 countries in 1970, but in only 6 by 1973. In April 1978, WHO officials announced that the world's last known case of naturally occurring smallpox had been located in Somalia in October 1977. However, health workers continued to watch for new cases for the next two years. In late summer of 1978, two cases occurred in England as the result of smallpox viruses kept in a laboratory at Birmingham University. In May 1980, WHO formally announced that smallpox had been eliminated.

Smeaton, John (1724-1792), a British engineer, designed the third Eddystone lighthouse off the English coast. Disregarding the advice of other engineers, he built it of stone blocks dovetailed together. His light-

house stood for more than 100 years before it was dismantled. Smeaton also designed and built bridges, water mills, harbour works, canals, drainage works, and other projects. He greatly improved the Newcomen steam-engine. He was the first person to call himself a *civil engineer*, and in 1771 he founded the Society of Civil Engineers. Smeaton was born at Austhorpe, near Leeds, England.

Smell is one of the most important and basic senses in animals and human beings. Some animals use the sense of smell to recognize their home territory, animals of their own kind, and other kinds of animals. They also use smell to find food and mates. Insects and some other animals *secrete* (give off) a substance called a *pheromone* in order to communicate by means of smell with their own species (see *Pheromone*). The pheromone secreted by certain female moths can be detected by males of the same species from several kilometres away. The scientific term for smell is *olfaction*, and the system by which we smell is the *olfactory system*.

How odours are detected. We detect smells by breathing or sniffing air that carries odours. Odours come from molecules of gas that have been released into the air from many different substances. These molecules stimulate *receptor cells* deep inside the nose. The cells, which are part of the olfactory nerves, are on layers of mucus-covered tissue. This tissue covers nasal bones called *turbinates* or *conchae*. The receptor cells send the impulses created by the odour along the olfactory nerves.

The olfactory nerves then carry the impulses to a part of the brain called the *olfactory bulb*. In dogs and some other *vertebrates* (animals with backbones), the olfactory bulb is large, but in human beings it is small. The size of an animal's olfactory bulb is an indication of how impor-

tant the sense of smell is to that animal. From the olfactory bulb, the nerve impulses travel to the *forebrain*, the front part of the cerebrum of the brain. Here, the brain translates the nerve impulses it has received into information about the odour.

Scientists do not know exactly how different smells are distinguished. One explanation is that molecules of certain odours become more quickly and more strongly attached to the mucus at a particular place on the turbinates than do other molecules. Therefore, molecules of certain kinds of odours will always stimulate the same receptor cells on the conchae. According to this theory, then, an odour is distinguished by how fast and where its molecules become attached to the receptor cells.

Taste and smell. Generally, we taste and smell food at about the same time. Thus, we have come to think of the two senses as being related. But they are, in fact, separate. Only at some point in the brain are the separate senses combined.

The smell-stimulus parts in food can be separated from the taste-stimulus parts. This can be done by blowing very clean air into the nose at the same time that food is put into the mouth. When this is done, people cannot identify some foods and beverages—for example, chocolate and coffee—though they still taste them. Some substances that are usually thought of as being smells, such as chloroform, have been found to be tastes.

See also *Dog* (Senses); *Insect* (Smell); *Nose*; *Senses*; *Taste*.

Smelling salts are used to relieve faintness and headaches. The salts are made up of ammonium carbonate mixed with perfume. This drug is known as a stimulant. The ammonia fumes from the salts irritate the membranes of the nose and lungs. This irritation results in a reflex which causes the muscles controlling breathing to work faster.

See also *Ammonia*.

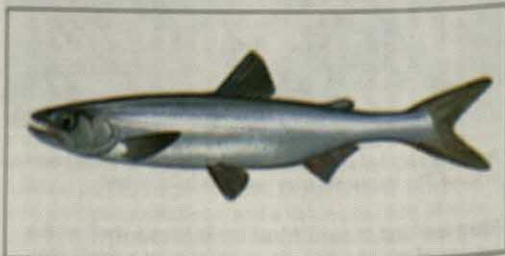
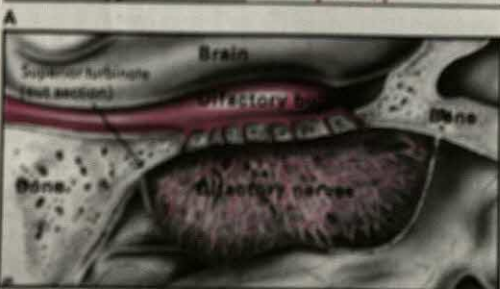
Smelt is a family of silvery fishes found in cool waters of the Northern Hemisphere. There are 10 species. Most measure less than 20 centimetres long. Like trout and salmon, smelts have a small, fleshy fin behind the dorsal fin on the back.

Some species of smelts live only in salt water—in the northern parts of the Atlantic and Pacific oceans and in the Arctic Ocean. Other species live only in freshwater rivers and streams that drain into these oceans, and in land-locked lakes. Still other species live chiefly in salt water but move to fresh water to *spawn* (lay eggs).

The *European smelt*, also known as *sparring*, is one

Our sense of smell

Odours are smelled when molecules of a substance travel through the nasal passages and touch the olfactory nerves. These nerves carry messages about odours to the brain.



Smelts are small relatives of salmon and trout. Like them, smelts have a small, fleshy fin on the back behind the dorsal fin.

species that lives in shallow coastal waters and estuaries. It migrates up rivers to spawn. The eggs are laid on sand or gravel. At first the eggs stick to the stones, but later they float in the water by means of a parachute-like extension of the egg membrane.

The *pond smelt* belongs to the same family but is a different *genus* (type) of fish. It is found mainly in freshwater in northern Asia and northern parts of North America. It is about 20 centimetres long and has a pronounced silver stripe along its sides.

Smelts are valuable food fish, and many are sold frozen. Some people consider fresh smelt a delicacy.

Scientific classification. Smelt belongs to the family *Osmeridae*. The European smelt is *Osmerus eperlanus*. The pond smelt is *Hypomesus olidus*.

See also Candlefish.

Smelting is a method by which metals are taken from their original ore. Smelting is done in specially built furnaces. The blast furnace for making pig iron is as tall as a 10-storey building. Iron ore, coke, and limestone are fed through the top of the furnace. Hot blast (preheated air) enters at the bottom. This burns the coke and generates the gases and heat required to reduce iron from its oxide minerals in the ore and to form *slag* by the reaction of limestone and such unwanted ore components as silicon and phosphorus (see *Slag*). Molten slag and iron are removed through openings in the bottom. Furnace gas is removed at the top. Industry also uses blast furnaces to smelt other ores to produce copper, lead, and *ferroalloys* (alloys containing iron).

The *reverberatory furnace* is a type of smelter commonly used to refine copper. This smelter uses hot combustion gases to melt both the solid ore and certain *flux materials* that are added to promote melting and to prevent oxide formation. In *flash smelting* of copper ores, heat is generated by the reaction of oxygen with the sulphur in the ore minerals. The sulphur oxides that result can be used to make sulphuric acid as a by-product. During flash smelting, the copper sinks to the bottom of the smelter in a liquid form called *matte*. Matte, which contains iron sulphides (ferric and ferrous) and small amounts of other sulphide compounds, is then refined to isolate copper.

See also **Copper** (Smelting); **Flux**; **Gold** (Idiagram); **Industrial Revolution** (Early ironmaking); **Iron and steel** (How iron is made); **Metallurgy** (Smelting).

Smetana, Bedřich (1824-1884), was a Czech composer. He and Antonín Dvořák are considered founders of the Czech national school of music. Smetana's eight operas established the Czech national operatic tradition. The most popular of these operas is *The Bartered Bride* (1866), though the most patriotic is *Libuše* (1872). His cycle of six symphonic poems, *Ma Vlast* (My Fatherland, 1879) is also famous. It includes the familiar *River Moldau*. Smetana's autobiographical String Quartet in E minor, *From My Life* (1876), influenced later quartets by the Czech composer Leoš Janáček.

Smetana was born in Litomyšl, near Pardubice, Bohemia, in what is now the Czech Republic. He grew up speaking German, but joined Czech patriots in an unsuccessful 1848 revolution against Prussian domination. From 1856 to 1861, Smetana directed a choral society and orchestra in Göteborg, Sweden. From 1866 to 1874, he served as conductor of the National Theatre in

Prague, where he introduced many new Czech, German, and French operas.

Smilax is a group of woody or herbaceous vines with hardy, tuberous roots and veined evergreen leaves. The stems end in tendrils by which the plants climb. The vines grow in temperate and tropical climates, and bear small clusters of red, blue, or black berries. Some species yield *sarsaparilla*, and others have stems that can be worked into baskets.

Scientific classification. Smilax belongs to the lily family, *Liliaceae*.



The common greenbrier is a type of smilax.

Smiles, Samuel (1812-1904), was a British reformer and an advocate of self-education and self-reliance. To spread his beliefs, he published *Self Help* (1859), and several similar books. Smiles was born at Haddington, in Scotland. He studied medicine but became a journalist and, later, a company secretary.

Smith was the family name of two Australian brothers who made the first flight between the United Kingdom (UK) and Australia. In 1919, the Australian federal government offered a prize to the first Australian who would fly from the UK to Australia within 30 days. The two brothers, together with James Bennett and Wallace Shiers, flew a Vickers Vimy bomber from the UK to Australia in just under 28 days. They were the only crew to complete the course in time. Both brothers were knighted for their achievement.

Sir Keith Smith (1890-1955) was a pilot and aircraft engineer. He was born in Adelaide, South Australia. He trained as a pilot in the UK during World War I (1914-1918) and served with the Royal Air Force. He later became the representative in Australia for a British aircraft manufacturing company and held high positions in a number of airline companies.

Sir Ross Smith (1892-1922), also born in Adelaide, was a noted pilot. During World War I he served as a soldier with a light horse regiment, then joined the Australian Flying Corps in 1916. In the later stages of the war, he was appointed personal pilot to T. E. Lawrence (see Lawrence, T. E.). Smith helped Lawrence in his efforts to win the support of the Arabs for the Allies. In



Sir Keith Smith



Sir Ross Smith

1918, Smith broke the record for the world's longest flight by flying nearly 3,782 kilometres from Cairo to Calcutta. He and Bennett were killed in England while testing an aeroplane.

Smith, Adam (1723-1790), is generally regarded as the founder of modern economics. Smith's major book was *The Wealth of Nations* (full title: *An Inquiry into the Nature and Causes of the Wealth of Nations*). Published in 1776, it was the first complete work on political economy. The book discusses the relationship between freedom and order, analyses economic processes, and attacks the British mercantile system's limits on free trade (see *Mercantilism*). All three aspects are woven together to create a unified social theory.

The book dealt with the basic problem of how social order and human progress can be possible in a society where individuals follow their own self-interests. Smith argued that this individualism led to order and progress. In order to make money, people produce things that other people are willing to buy. Buyers spend money for those things that they need or want most. When buyers and sellers meet in the market, a pattern of production develops that results in social harmony. Smith said that all this would happen without any conscious control or direction, "as if by an invisible hand."

Smith also believed that labour—not land or money—was both the source and the final measure of value. He said that wages depended on the basic needs of workers, and rent on the productivity of land. Profits, he said, were the difference between selling prices and the cost of labour and rent. Smith said profits would be used to expand production. This expansion would in turn create more jobs, and the national income would grow.

Smith believed that free trade and a self-regulating economy would result in social progress. He criticized the British government's tariffs and other limits on individual freedom in trade. He preached that government need only preserve law and order, enforce justice, defend the nation, and provide for a few social needs that could not be met through the market. Smith's argument for a "hands off" government policy toward business and his analysis of economic forces formed the basic ideas of *economic liberalism*. See *Liberalism*; *Capitalism*.

Smith was born in Kirkcaldy, Scotland. He studied at the University of Glasgow and Oxford University. In 1751, he became a professor at Glasgow. He wrote *The Theory of Moral Sentiments* (1759) there. This philosophical work gained Smith an appointment in 1764 as tutor of the young duke of Buccleuch. The tutoring took Smith to France, where he started writing *The Wealth of Nations*. When Smith returned to England in 1766, the duke's stepfather provided Smith with a regular income. This enabled him to devote the next 10 years to writing.

The Wealth of Nations went through five editions during Smith's lifetime. But it had little major influence on economic policy until the early 1800's.

Smith, Bessie (1894-1937), became one of the finest blues singers in the history of jazz. A series of recordings she made from 1923 to 1933 rank among the best in jazz. Smith applied the strength and beauty of her voice to simple songs. Louis Armstrong, Fletcher Henderson, Joe Smith, and James P. Johnson were among the jazz musicians who played on her records.

Bessie Smith was born in Chattanooga, Tennessee,

U.S.A., into extreme poverty. She left home when she was a teenager to tour with a minstrel show. A recording director discovered her and brought her to New York City. The black public bought millions of her records during the years of her greatest fame from 1923 to 1928. Her work was almost unknown to white audiences until shortly before her death. Smith died of injuries suffered in a car accident in Mississippi.

Smith, Sir Charles Kingsford. See *Kingsford Smith, Sir Charles*.

Smith, Fanny Cochrane (1834-1905), was probably the last of the tribal Aborigines of Tasmania, Australia. Fanny Cochrane was one of the few Aboriginal children born at the Wybalenna settlement on Flinders Island. Her people, numbering 135, were virtually imprisoned at Wybalenna, and many died of lung disease, poor food, despair, and homesickness. Her mother was Tanagerooturra of the North-East tribe, but her father's identity is unclear. At one time, it was believed that the sealer John Smith was her father. But recent research suggests that Nicermenic, from Robbins Island in north-west Tasmania, fathered her. If so, Fanny would have been the last tribal Tasmanian Aborigine, outliving Truganini by 29 years. See *Truganini*.

In 1847, Fanny and the remaining 46 tribal Aborigine survivors were transferred to the damp and unhealthy Oyster Cove settlement. But Fanny left Oyster Cove in 1854 when she married William Smith, a local sawyer. They ran a boarding house in Hobart until 1858, then moved to the Nicholls Rivulet area, near Cygnet. There, Fanny had been awarded a land grant by the Tasmanian government in recognition of her rights as an Aborigine. The couple raised 11 children, and Fanny became well known and respected in the white community. She was a firm Methodist, an excellent cook and hostess, and a fine singer. Fanny never gave up her Aboriginal identity and culture. She was recorded in 1899 and 1903 singing the songs of her people, learnt while she was a child.

Smith, Francis Graham (1923-), became the United Kingdom's Astronomer Royal in 1982. He also became professor of radio astronomy at Manchester University in 1981, and director of Nuffield Radio Astronomy Laboratories, Jodrell Bank, also in 1981. Smith was educated at Downing College, Cambridge. He was professor of radio astronomy at Manchester from 1964 to 1974 and served as director of the Royal Greenwich Observatory from 1976 until 1981.

See also *Astronomer Royal*.

Smith, Ian Douglas (1919-), served as prime minister of Rhodesia—which is now called Zimbabwe—from 1964 to 1978. After Smith became prime minister, he sought Rhodesia's independence from the United Kingdom (UK) under a constitution that would have allowed Rhodesia's small white minority to continue to rule the black majority indefinitely. The UK refused, and on Nov. 11, 1965, Smith declared Rhodesia independent without the UK's consent.

The UK, the United States, and the United Nations imposed economic restrictions and an oil embargo on Rhodesia. But Smith continued to support white minority rule. Black Rhodesians began a guerrilla war to try to topple the white government. In the late 1970's, Rhodesia's white rulers, led by Smith, agreed to black demands for a black-controlled government. Smith served

as part of a transitional government in 1978 and 1979. A black government was formed in 1979. Smith became an ordinary member of the country's parliament. He was suspended in 1987 for criticizing the government.

Smith was born in Selukwe, Rhodesia (now Shurugwi, Zimbabwe). He was a member of Southern Rhodesia's parliament from 1948 to 1953, and of the Federation of Rhodesia and Nyasaland federal assembly from 1953 to 1961. Smith was elected to the Rhodesian parliament in 1962, and he served as deputy prime minister and treasury minister until 1964.

Smith, James (1827-1897), known as *Philosopher Smith*, discovered the rich tin mine at Mt. Bischoff in the Australian island state of Tasmania in 1871. He formed the Mount Bischoff Tin Mining Company in 1873. He served in parliament from 1886 to 1888, then retired to his farm at Forth. Born at George Town in Tasmania, he worked as a flour miller's apprentice and prospected for gold in Victoria.

Smith, James (1897-1968), a South African expert on fish, was the first person to identify the *coelacanth* as a living species. The coelacanth is a primitive fish that lived 300 million years ago. It was believed to be extinct.

James Leonard Brierley Smith was born at Gaaff-Reinet in the Cape Colony. In 1923, he became a lecturer in chemistry at Rhodes University, Grahamstown. Smith's passion for fishing led him to devise a unique system of fish classification. In January 1939, the curator of the East London Museum, Marjorie Courtenay Latimer, sent him a sketch of a strange fish, and asked him to identify it. It had been netted the previous year off the southeast coast of South Africa. Smith was convinced that it was a coelacanth and classified it scientifically as *Latimeria chalumnae*. Several expeditions were mounted to look for a second specimen, which eventually turned up alive in 1952. Since then, several more specimens have been caught. At Rhodes, Smith was honoured by being appointed the first professor of *Ichthyology* (study of fishes) in South Africa.

See also *Coelacanth*.

Smith, John (1580?-1631), was an English soldier and adventurer. He helped establish the first permanent English colony in America, at Jamestown, Virginia.

Smith was born in Willoughby, near Louth, England. In 1607, Smith and a group that sailed from England landed in Virginia. They founded a settlement, which they named Jamestown in honour of King James I. Smith served as president of the colony from 1608 to 1609 then returned to England.

Smith returned to America in 1614 and spent several months exploring the coast in the Massachusetts Bay area. He later named this region "New England."

In his later years, Smith lived in London and wrote several books that promoted American colonization. His most influential book was *The Generall Historie of Virginia, New-England and the Summer Isles* (1624).

Smith, John (1938-1994), a British politician, was leader of the Labour Party from 1992 until his death in 1994. He succeeded Neil Kinnock, who resigned as leader after the Labour Party's defeat in the 1992 general election. Smith was first elected to Parliament in 1970, as the member for North Lanarkshire, Scotland. In 1978, he was appointed secretary of state for trade. Smith became one of the *shadow cabinet* (the leading members

of the opposition party) in 1979. When constituency boundaries were changed in 1983, Smith became the member for Monklands East. He was chief opposition spokesman on employment from 1983 to 1984 and on trade and industry from 1984 to 1987. In 1987 Smith became shadow chancellor of the exchequer. As shadow chancellor at the 1992 general election, John Smith drew up a shadow budget which proposed higher taxes from higher earners. Some blamed Smith's budget for the Labour Party's third consecutive general election defeat at the polls.

In 1992, Smith was elected leader of the Labour Party, soundly defeating rival Bryan Gould. As leader, he continued a programme to modernize the Labour Party. He campaigned for an end to the trades union *block vote*, in which union delegates at party conferences had voting power directly related to the size of their unions. Smith called for a "one member, one vote" policy. The party's acceptance of the policy in 1993 consolidated John Smith's leadership.

Smith's style of leadership was cautious and conciliatory. His adversaries regarded him as a formidable opponent in Parliamentary debates. He also worked hard to win support for Labour among business and City leaders. His unexpected death from a heart attack in 1994 came as a great shock to members of all parties.

Smith was born in Argyll, Scotland. He was educated at Glasgow University, and studied history and law.

Smith, Joseph (1805-1844), was the founder and first president of the Mormon Church, officially called the Church of Jesus Christ of Latter-day Saints. Several other churches recognize him as their founder. The largest of these is the Reorganized Church of Jesus Christ of Latter Day Saints.

Smith was born in Sharon, Vermont, U.S.A. Smith said the angel Moroni visited him in 1823, and told him he would receive gold plates on which he would find a book engraved in a strange language. Smith said he received the plates in 1827. His translation of the writings, called the *Book of Mormon*, was published in 1830.

On April 6, 1830, Smith and five associates founded the Church of Jesus Christ of Latter-day Saints at Fayette, New York, with Joseph Smith as its leader. Smith moved to Kirtland, Ohio, in 1831, and made many converts there. Smith instituted many of the church's present doctrines and its basic organization at Kirtland. He organized the *quorums* (groups) of the priesthood, which gave most male church members priestly authority. Later, he introduced *tithing* (giving one-tenth of one's income to the church).

Joseph Smith and the Mormons founded the city of Nauvoo (*the plantation beautiful*) in the state of Illinois. Nauvoo's population reached 20,000 in the early 1840s. Smith instituted the doctrine of *polygamy* at Nauvoo in 1843. Polygamy is the practice of a man having more than one wife at the same time. The church finally out-



John Smith

lawed polygamy in 1890. Some members who did not agree with the doctrine of polygamy broke away in 1844. They set up a newspaper that criticized Smith. The paper was destroyed, and Smith was blamed for it. Smith and his brother Hyrum were jailed at Carthage, Illinois, on charges of rioting and treason. A mob attacked the jail and killed the brothers on June 27, 1844. But the church continued to grow after Joseph Smith's death. Brigham Young led the main body of Mormons to present-day Utah, where they prospered.

Smith wrote the *Pearl of Great Price* (1830, 1835) and *Doctrine and Covenants* (1835) based on his revelations. He wrote an autobiography in 1842.

See also **Mormons**; **Latter Day Saints**, **Reorganized Church of Jesus Christ of**.

Smith, Margaret. See **Court, Margaret**.

Smith, Sydney (1771-1845), a British clergyman and writer, was a well-known wit. As a satirist, he championed many reforms. His best-known work is *Letters on the Subject of the Catholics* (1807-1808), better known as *The Letters of Peter Plymley*. The letters satirized people's attitude toward the restrictions on Roman Catholics, who were not permitted to vote or hold office at that time. Smith was born at Woodford, in Essex, England, and educated at Winchester College and Oxford University.

Smith, William (1769-1839), a British geologist and engineer, discovered how to recognize rock formations by their fossils. He also published the first geological map of England and Wales. Smith was born at Churchill, in Oxfordshire, England. He was self-educated in engineering and geology. He started work as a surveyor's assistant and became a canal and drainage engineer. Smith collected fossils, studied rocks, and arranged them according to their ages. He published his *Geological Map of England and Wales, with part of Scotland* in 1815.

Smith Act, or Alien Registration Act of 1940, makes it a crime to advocate the violent overthrow of the United States government or to belong knowingly to a group advocating it. In 1951, the Supreme Court upheld the act in the case of 11 convicted leaders of the Communist Party. But in 1957, the court ruled that teaching Communism or other revolutionary theories was not, in itself, grounds for conviction. Proof was required that the defendant had urged the overthrow of the government.

In 1961, the Supreme Court again upheld the conviction of a member of the Communist Party under the act. The court held that in this case the person had been an active member of the Communist Party and had intended to overthrow the government of the United States.

Smithfield Market is the distributing centre for London's meat. It lies in the City of London. It was built in 1886 by Sir Horace Jones, and covers an area of 4 hectares. Smithfield was the place of execution of Sir William Wallace, the Scottish patriot, in 1305, and of Wat Tyler, the leader of the peasants' revolt, in 1381.

Smithson, James (1765-1829), a British scientist, founded the Smithsonian Institution in the United States. In his will he gave more than 500,000 U.S. dollars to the United States for the establishment of a scientific institution. The U.S. Congress accepted this gift and in 1846 created the Smithsonian Institution at Washington, D.C.

Smithson was born in France, and was educated at Oxford University. Smithson became known for his researches in chemistry and mineralogy. One of the many minerals that he studied was named *smithsonite* (zinc carbonate) in his honour.

See also **Smithsonian Institution**.

Smithsonian Institution is an American, federally chartered nonprofit corporation of scientific, educational, and cultural interests. James Smithson, a British scientist, left his fortune to the United States in 1829 to found an establishment for the "increase and diffusion of knowledge among men." The U.S. Congress established the Smithsonian on Aug. 10, 1846. The institution is based in Washington, D.C.

The Smithsonian operates numerous museums. Many of them display works of art. Others feature exhibits on American history, natural history, aeronautics and space exploration, or science and technology. Other facilities operated by the Smithsonian include a zoo and centres for scientific research and cultural exchange.

See also **Smithson, James**.

Smog is a form of air pollution. The term was first used in 1905 to describe the combination of *smoke* and thick *fog* that at times hung over London and other cities in the United Kingdom. Today, smog also refers to a condition caused by the action of sunlight on the exhaust gases from motor vehicles and factories. This type of smog is sometimes called *photochemical smog*.

Weather conditions such as a lack of wind or a *thermal inversion* may cause smog to build up in an area. A thermal inversion occurs when a layer of warm air settles over a layer of cool air near the ground. This prevents the smog from rising and scattering. Mountain ranges near cities may also trap smog in an area.

Heavy concentrations of smog are poisonous. In 1948, 20 people died and nearly 6,000 became ill from a photochemical smog over Donora, Pennsylvania, U.S.A. About 4,000 Londoners died within five days as a result of a thick smog in 1952. Smog also destroys plant life and speeds deterioration of building materials.

London-type smog occurs when moisture in air condenses on smoke particles produced by the burning of coal, forming tiny smog droplets. A dangerous part of London-type smog is sulphur dioxide, a gas that attacks the lungs and makes breathing difficult. For this reason, London-type smog is sometimes called *sulphur smog*.

Photochemical smog involves the action of sunlight on *hydrocarbons* and *nitrogen oxides* in the air. These compounds are chemicals formed by the burning of petrol and other petroleum products. When activated by sufficient sunlight, the compounds undergo a chemical reaction that produces gases called *oxidants*. Ozone forms the most abundant oxidant in photochemical smog. It can irritate the eyes, nose, and throat and damage the lungs. Other oxidants in smog include nitrogen dioxide and peroxyacetyl nitrate (PAN).

See also **Air pollution**; **Ozone**.

Smoke consists of finely divided solid and liquid particles that are *suspended* (held) in a gas. Smoke is mostly made up of particles of carbon that are produced by the burning of fuel. Smoke can harm the lungs. It also blackens buildings, corrodes metals, and damages vegetation, causing serious economic losses. Smoke has a few helpful uses. These uses include preserving meats, pro-

ducing coloured military signals, and protecting orchards from the effects of frost.

Smoke may become dangerously concentrated during a weather condition called *thermal inversion*. This condition occurs when a layer of warm air settles over a layer of cooler air that lies near the ground. The warm air traps the cool air and prevents the smoke from rising and scattering.

See also **Air pollution; Environmental pollution.**

Smoke detector, also called *smoke alarm*, is a device used in homes and other buildings to warn people of smoke or a fire. It makes a loud buzzing noise within seconds after smoke enters it through special vents.

There are two kinds of smoke alarms, *ionization detectors* and *photoelectric detectors*. In an ionization detector, a tiny radioactive cell electrically charges molecules of air, creating particles called *ions*. The ions produce an electric current that flows continuously. Smoke particles become attached to the ions and reduce the flow of the current, setting off the alarm.

A photoelectric detector contains a light source that shines into a chamber, plus a light-sensitive device called a *photocell*. Smoke scatters the light from the source and reflects it onto the photocell. The photocell then triggers the alarm.

According to fire protection experts, both types of smoke detectors work equally well in warning of fire. Ionization detectors react faster to flaming fires, and photoelectric alarms respond more quickly to smouldering fires. Both are manufactured as battery-operated or plug-in models. A smoke detector should be installed on a ceiling, at least 15 centimetres from the wall, or on a wall, between 15 and 30 centimetres from the ceiling. Fire protection experts recommend at least one detector for each floor of a residence. At least one alarm should be installed near the bedroom area.

Smoke signal. See **Indian, American (Other communication).**

Smoking is drawing tobacco smoke from a cigarette, cigar, or pipe into the mouth—and often into the lungs—and puffing it out. The term usually refers to cigarette smoking, the most common form of smoking.

People have smoked tobacco for thousands of years. American Indians, for example, smoked tobacco in pipes during religious ceremonies long before white people went to the New World. In the 1500s, many Europeans began smoking because they believed tobacco had medicinal benefits. Today, people smoke chiefly for relaxation and pleasure, and to satisfy a craving for *nicotine*, a chemical substance in cigarette smoke. However, during the 1900s, scientists found increasing evidence that smoking can endanger a person's health.

In 1964, the United States surgeon general first officially warned of the health hazards of smoking. Since then, there have been numerous reports linking cigarette smoking to heart disease; lung disease; cancers of the lung, mouth, and other tissues; and other ailments. Cigar and pipe smoking have been linked to cancers of the mouth.

In spite of the dangers, many people become smokers. Many young people begin smoking as an act of rebellion or independence. Most adults smoke to reduce their craving for nicotine. The effects of nicotine help make smoking pleasurable. Nicotine stimulates the nerv-

ous system and the heart and other organs. However, its effect on the nervous system also causes many people to become addicted to it. Such an addiction makes it hard for people to give up smoking.

Why smoking is dangerous. Cigarette smoke contains thousands of chemical substances, many of which have been linked to the development of diseases. Chemical substances occur in cigarette smoke as gases or as *particulates* (tiny particles).

Gases in cigarette smoke that pose a great threat to health include hydrogen cyanide, nitrogen oxides, and, especially, carbon monoxide. Carbon monoxide is a poisonous gas that readily combines with *haemoglobin*, a substance in the blood that transports oxygen to body tissues. Carbon monoxide in the blood prevents oxygen from reaching the brain and the heart and other muscles. Continual exposure to the high levels of carbon monoxide associated with cigarette smoking is believed to lead to heart disease.

Particulates in cigarette smoke are often referred to as *tar*. These particulates include a variety of health-damaging substances, of which nicotine is the most hazardous. A thimbleful of nicotine—about 60 milligrams—could kill an adult if taken all at once. A typical cigarette contains about 1 milligram of nicotine. The body prevents the accumulation of fatal doses by quickly breaking down the nicotine from each cigarette. However, nicotine raises the blood pressure, increases the heart rate, and contracts blood vessels near the skin. Its effects on the body, along with the effects of carbon monoxide, may contribute to the high rate of heart disease among smokers. Nicotine also is believed to contribute to the growth of several types of cancer.

The particulates in tobacco smoke have different effects on lung function, depending on how well the cigarette is filtered, how far the cigarette is smoked, and how large the particulates are. Cigarette filters remove some nicotine and other particulates from cigarette smoke. But the concentration of particulates in the last three puffs of a cigarette is as much as 67 times greater than the concentration in the first three puffs.

During smoking, the larger particulates get deposited on the mucous lining of the lungs and the larger airways that lead into the lungs. Over time, the large particulates and certain gases in the cigarette smoke scar the lungs and damage the *cilia*, thousands of little hairs that line the airways. The cilia normally help move mucus—and the pollutants that accumulate in mucus—out of the lungs and toward the throat. The mucus is then swallowed or spat out. In heavy smokers, the cilia are paralysed and the pollutants remain in the lungs. As a result, a smoker's chances of developing bronchitis and influenza increase. Deposits of small particulates in the smaller airways of the lungs can lead to a lung disease called *emphysema*. See **Emphysema**.

Smoking and disease. Cigarette smoking is a leading cause of many life-threatening diseases. The rate of death from cancer and heart disease is twice as high among smokers than among nonsmokers. People who smoke two or more packets of cigarettes daily are three or four times more likely to have cancer or heart disease than are nonsmokers. Also, the efficiency of the lungs decreases with age much faster in smokers. The first study on the effects of smoking showed that men who

were lifelong smokers died almost 18 years earlier than men who had never smoked. According to the report, a 30-year-old man who smokes can expect to die at the age of 64; a man of the same age who has never smoked can expect to live until the age of 82 years. The survey was carried out in a town in Pennsylvania, U.S.A.

Increasing evidence indicates that cigarette smoke also harms nonsmokers. The inhalation of another person's cigarette smoke is called *passive smoking*. Research increasingly indicates that passive smoking contributes to thousands of cases of lung cancer and heart disease in nonsmokers annually. Also, infants under one year of age whose mothers smoke have twice as many lung infections as infants of nonsmoking mothers.

Smoking also has been associated with various complications during pregnancy. Pregnant women who smoke have a higher rate of miscarriage than do non-smoking mothers. Infants born to smoking mothers tend to have a lower-than-normal weight at birth, which is dangerous to their health.

How smokers stop. Since doctors and governments first warned about the health hazards of cigarette smoking in the 1960s, millions of people have stopped smoking. Most of them have been able to stop on their own, although some made several attempts before they were able to stop completely. Many smokers attend special clinics set up to help them overcome their addiction. At these clinics, smokers learn how to avoid situations that make them think about smoking and how to reduce feelings of stress without smoking. For example, smokers learn to become aware of each cigarette that they smoke and to substitute smoking with other activities, such as exercise.

Smoking regulations. Since the 1970s, many countries have introduced measures to discourage smoking. Some have passed laws that require cigarette advertising and packaging to carry a health warning; some have banned cigarette advertisements from radio and television. In many countries, smoking is prohibited on public transport and in some public places, such as hospitals, schools, theatres, and cinemas. Many private companies regulate or prohibit smoking in the workplace as well.

See also **Tobacco**.

Smoky Mountains, Great. See **Great Smoky Mountains**.

Smollett, Tobias George (1721-1771), was one of the great early English novelists. His novels are loosely constructed accounts of amusing and sometimes vulgar incidents in the hero's life. They are read for their eccentric characters, their bitter social satire, and their broadly comic high spirits.

Smollett was born near Dumbarton, Scotland, and became a doctor. After an adventurous life at sea as a ship's doctor, he settled in London. His first two novels, *The Adventures of Roderick Random* (1748) and *The Adventures of Peregrine Pickle* (1751), draw heavily on his sea experiences. *The Expedition of Humphry Clinker* (1771) is generally considered his best novel. Told in letters, it gives a vivid picture of a family travelling through England and Scotland.

Smooth fox terrier is a small, alert dog originally bred for use in fox hunts. A smooth fox terrier stands about 40 centimetres tall and weighs about 8 kilograms. The dog is white in colour with patches of black or tan,

or both black and tan. Its coat is smoother than that of the wire fox terrier (see **Wire fox terrier**). A smooth fox terrier has legs well suited for running.

The smooth fox terrier breed was developed in southern England in the mid-1800s. The dog has good eyesight and a keen sense of smell. It is also fast and strong for its size. The dog makes an excellent companion for children or adults.

See also **Dog** (picture: Smooth fox terrier).

Smörgåsbord. See **Sweden** (Food).

Smuggling is the illegal transportation of people or goods into or out of a country or area. People who smuggle goods are usually trying to avoid the payment of *customs duties*, or taxes (see **Tariff**). However, drug smugglers are trying to share in big profits for illegal drugs—that is, drugs whose possession and sale are forbidden by law.

Most countries have customs officers stationed at seaports and along their borders. These officers may examine shipments of merchandise as well as the baggage of travellers to make sure that customs duties are paid. Sometimes a country may have laws prohibiting the importation of particular articles, such as firearms, obscene publications, and alcoholic drinks. There are also restrictions on taking certain plants, animals, or food into countries. Violation of such laws also is called smuggling. Today, illegal drugs involved in smuggling include marijuana, cocaine, and heroin.

People who are guilty of smuggling may be punished by fines or imprisonment, and by having the goods taken away from them, according to the seriousness of the offence.

Smut is the name of a group of related fungi that live as parasites in certain plants and cause diseases in them. Smut gets its name from the fact that it produces tiny black spores that look like particles of soot. Smuts are dangerous to both cultivated and wild plants. They are particularly harmful to such agricultural crops as wheat, oats, barley, maize, and rice. Smuts usually destroy the seeds or entire clusters of flowers. The plant may then become completely useless as a crop or unable to produce seeds.

One of the most common of all smuts is the *corn smut*. It usually grows on the ears of maize plants, causing large growths that resemble boils. Sometimes these growths also occur on the tassels. The spores of corn smut may live in the soil, or in manure that has come from animals fed with infected maize stalks. These spores may later infect plants with which they come in contact. As the maize plant develops, the tiny threads of smut grow within the tissues of the plant. These threads produce large blotches of dark-brown spores in the ears, the tassels, and sometimes the leaves of the plant.

The best way to prevent corn smut is by *rotation of crops*—that is, changing the location of the crops each year. Rotation of crops helps prevent smut because the spores do not usually live in the soil for more than a year. Also, all plants affected with smut should be destroyed to prevent the transfer of the infection.

The *oat smuts*, *stinking smut* of wheat, and the *covered smut* of barley are three common smuts that are dangerous to cereal crops. The spores of these smuts are dusted on the outside of the seeds when the crop is *threshed*. Threshing involves the separation of the seed

from the straw. When seeds carrying smut spores are sown, the spores sprout and infect the young seedlings. The spores can be destroyed by treating the seeds with a disinfecting solution, such as *copper sulphate*, or with a special fungicide.

Scientific classification. Smut are fungi that belong to the division Ustilaginomycetes, order Ustilaginales. There are two families, Ustilaginaceae and Tilletiaceae.

Smuts, Jan Christiaan (1870-1950), was a South African soldier, scholar, and statesman. He fought against Great Britain in the Boer War, but he later helped reconcile the Boers (Dutch settlers) and the British.

Smuts was born in Cape Town of an old Dutch family. He studied law at Cambridge University in England. He returned to Cape Town to study law, and became state attorney of the Transvaal Republic. When war broke out with Great Britain in 1899, Smuts received a command in the Boer Army. He became a skilful military leader and rose to the rank of general (see **Anglo-Boer Wars**).

In 1906, Great Britain gave the Transvaal self-rule, and Smuts worked hard for the union of the South African colonies. When the Union of South Africa was formed in 1910, Smuts became minister of the interior under Prime Minister Louis Botha (see **Botha, Louis**). Smuts later served as minister of defence, minister of finance, and minister of justice.

During World War I, Smuts fought for Great Britain, and served in London as a member of the British War Cabinet. At the Paris Peace Conference, Smuts became one of the authors of the Covenant of the League of Nations. When Botha died in 1919, Smuts became prime minister of the Union of South Africa.

The Nationalist party defeated Smuts in 1924. James Hertzog, the Nationalist leader, formed a coalition in 1933, with Smuts second in command. Smuts again became prime minister in 1939 on the platform of aiding Great Britain against Nazi Germany. During World War II, he became a British field marshal. In 1945, Smuts was mainly responsible for drafting the Preamble to the Charter of the United Nations.

Smuts was a champion of internationalism. He was an intellectual known for philosophic writings and profound speeches. He favoured a more liberal policy for the blacks of his nation. Smuts resigned in 1948 after the Nationalists defeated his party.

See also **South Africa (History)**; **United Nations (The Preamble)**.

Smyth, Dame Ethel (1858-1944), was one of the first women to distinguish herself as a composer. Her best-known works include *Mass in D major* and the opera *The Wreckers*. She also wrote works for most kinds of ensembles. Dame Ethel Smyth was born in London and studied at Leipzig and Berlin, in Germany. She spent much of her life abroad until the early 1900's. On her return to England, she actively supported the emancipation of women. In the 1930's, she became deaf and turned to writing.

Smyth, John. See **Baptists (Early history)**.

Smythe, Francis Sydney (1900-1949), was a noted British mountaineer, author, and photographer. He set up several new routes on the Brenvan Face of Mont Blanc in 1927 and 1928. In 1930, he took part in an attempt on Kanchenjunga, and, in 1931, led a successful attempt on Mt. Kamet. He took part in the Mt. Everest ex-

peditions of 1933, 1936, and 1938, and discovered the direct route to the top of the west side of the North Col. Smythe was born at Ivythorne, near Maidstone, in Kent. In 1927, he was invalided out of the Royal Air Force with a weak heart, but he continued climbing.

Smythe, Pat (1928-), established herself as one of the best horsewomen and showjumping riders in Britain. In 1949, she became showjumper of the year. In 1962, she won the Saddle of Honour at the Royal International Horse Show. Pat Smythe was born at East Sheen, in Surrey. She began to ride at the age of four. On *Finality*, she won several rosettes in the International Horse Show at the White City in 1947, when she was 18. Her horses included *Tosca*, *Prince Hal*, and *Flanagan*. In 1963, she married and became Patricia Rosemary Koechlin.

Snail is an animal whose soft body is usually covered with a coiled shell. A snail creeps along on a strong muscular organ called a *foot*. Its body has a head with *tentacles* (feelers), eyes, a mouth, and tiny teeth. There may be more than 80,000 kinds of snails. Some are smaller than a pinhead. Others grow up to 60 centimetres long.

Snails live almost everywhere—in forests, deserts, rivers, ponds, and all parts of the ocean. They eat many kinds of food. Many snails that live on land eat rotting plants. Snails that live in rivers and lakes feed on water plants and dead animals. Some sea snails feed on seaweeds, and some eat other sea animals. A few sea snails are *parasites*, and live in the flesh of starfish or inside living sea animals called corals. Snails may live from 2 to 20 years.

Many snails that live on land have both male and female sex organs in the same animal. Most of those that live in water are either male or female.

Groups of snails. Snails can be divided into three groups, according to where they live: on *land*, in *fresh water*, or in *salt water*.

Land snails are found in damp, shady places—under logs and stones, at the edges of ponds and rivers, and in woods. Most land snails live on the ground. But in tropical forests, many large, colourful kinds are found in the trees. All land snails have lungs.

The land snail uses its muscular foot to crawl about. The muscles of its foot move in a backward, wavelike



The giant African snail, one of the largest land snails, grows about 15 centimetres long. Farmers consider this snail a serious pest because it destroys many kinds of plants.

motion that propels the snail forward. A moving snail pours out a sticky slime, which helps the snail move. The snail's enemies, beetles and ants, sometimes get caught in the slime. In dry weather, the snail seals itself in its shell with a "door" of dried slime. It rests in this condition, which is called *aestivation*, until the dry spell ends.

Freshwater snails live in rivers, ponds, lakes, and hot springs. There are about 5,000 kinds of freshwater snails. Some of them have lungs, and must come to the surface to breathe the oxygen in air. Others have gills, which take in oxygen from the water.

Saltwater or marine snails are the largest group of snails. There are about 55,000 kinds. Some kinds live along the seashore. Some live on the ocean floor in the deepest parts of the ocean. Most marine snails have gills. Many of these snails have a shelly lid, called an *operculum*, which seals the animal in whenever it draws itself into its shell. People who collect shells prize the colourful shells of various saltwater snails.

Useful and harmful snails. Many snails are an important food for fish, birds, and crustaceans, such as crayfish and lobsters. Many people consider the *Helix* garden snail, which is known as *escargot*, a great delicacy. The *turban snail* of Australia is used to make pearly shirt buttons.

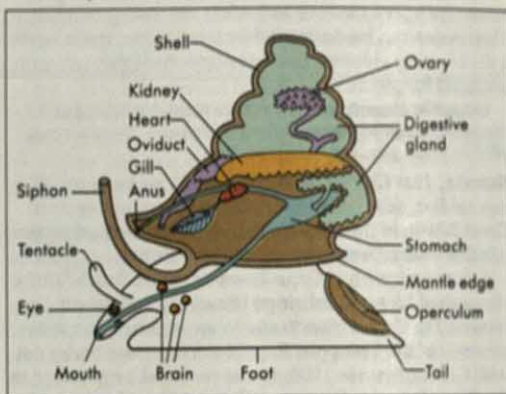
Certain freshwater snails of the tropics carry worms that cause *schistosomiasis*, a disease that kills thousands of people each year. The *giant African snail* destroys flowers, vegetables, and young rubber plants. This large snail is 15 centimetres long. Some kinds of *cone snails* of the Indian and Pacific oceans have a poisonous stinger 13 millimetres long. The poison is used to kill small fish and other prey, but it can also kill people. The sea snails that people eat can carry such diseases as typhoid fever and hepatitis, if they are taken from polluted water near sewers.

Scientific classification. Snails belong to the phylum Mollusca, class Gastropoda. Snails with gills are members of either the subclass Prosobranchia or the subclass Opisthobranchia. Those with lungs are in the subclass Pulmonata.

Related articles in World Book include:

Abalone	Mollusc (Gastropods)	Schistosomiasis	Slug
Conch	Periwinkle	Shell (pictures)	Whelk
Cowrie			
Limpet			

The body of a snail



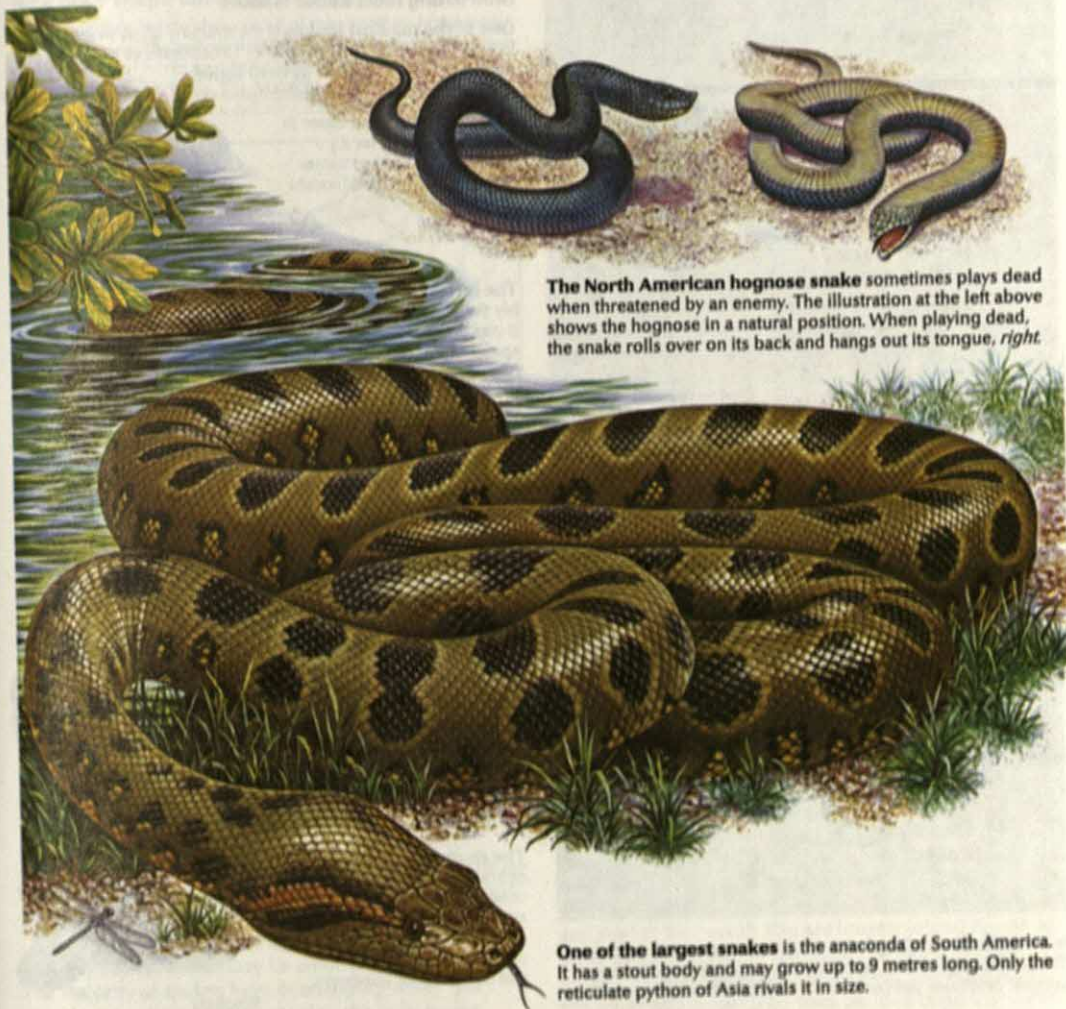
A land snail lays a cluster of small, rubbery eggs in a damp place, such as a shallow hole in moist ground.



The foot and mouth of a freshwater snail can be seen clearly as this creature clings to the side of a glass aquarium. Snails crawl by moving their foot muscles in a wavelike motion.



Cone snails live in the Atlantic, Indian, and Pacific oceans. They feed on small sea animals, which they paralyze with a poisonous sting. Human beings have died from cone snail stings.



The North American hognose snake sometimes plays dead when threatened by an enemy. The illustration at the left above shows the hognose in a natural position. When playing dead, the snake rolls over on its back and hangs out its tongue, right.

One of the largest snakes is the anaconda of South America. It has a stout body and may grow up to 9 metres long. Only the reticulate python of Asia rivals it in size.

Snake

Snake is an animal with a long, legless body covered by dry scales. To move about on land, a snake usually slides on its belly. Many snakes have such a flexible body that they can coil into a ball. The eyes of a snake are covered by clear scales instead of movable eyelids. As a result, its eyes are always open. Snakes have a narrow, forked tongue, which they repeatedly flick out. They use the tongue to bring odours to a special sense organ in the mouth.

Snakes belong to an *order* (group) of animals called *reptiles*. Reptiles also include crocodiles, lizards, and turtles. Like other reptiles, snakes can maintain a fairly steady body temperature by behavioural means. For example, they raise their body temperature by lying in the sun or lower it by crawling into the shade. In contrast, mammals and birds have internal mechanisms that regulate their body temperature.

Scientists have evidence that snakes developed from lizards about 100 million years ago. Snakes resemble lizards more than they do other reptiles. But unlike most lizards, snakes lack legs, movable eyelids, and external ear openings. Their scales and skulls also differ from those of lizards. Because of their special eye structure, snakes are thought to have developed from lizards that burrowed underground. Their loss of legs is also thought to have occurred as a result of this burrowing phase.

Snakes live almost everywhere on the earth. They live in deserts, forests, oceans, streams, and lakes. Many snakes are ground dwellers, and some live underground. Others dwell in trees, and still others spend most of their time in water. Only a few areas in the world have no snakes. Snakes cannot survive where the ground stays frozen throughout the year. No snakes live in the polar regions or at high elevations in mountains. In addition, snakes are often absent from islands, including Ireland and New Zealand.



Male rattlesnakes battle for the right to mate with a female. The snakes rear up and lunge at each other repeatedly. The combat continues until one snake is forced down and retreats.

There are about 2,700 kinds of snakes. The greatest variety dwell in the tropics. The largest snakes are the anaconda of South America and the reticulate python of Asia. Both may grow up to 9 metres long. One of the smallest snakes is the Braminy blind snake, which lives in the tropics and grows only 15 centimetres long. Like other blind snakes, the Braminy blind snake has eyes, but they are covered by head scales. Blind snakes probably can distinguish only light and dark.

Some snakes are poisonous. They have two hollow or grooved fangs in the upper jaw. The snakes inject *venom* (poison) through their fangs when they bite. About 270 kinds of snakes have venom that is harmful or fatal to human beings. About 25 kinds cause most of the deaths from snakebites. These snakes include the King cobra of Asia, the black mamba and the saw-scaled viper of Africa, and the taipan of Australia.

Some people fear and dislike snakes, partly because some kinds are poisonous and partly because their appearance and ways of life seem strange. Throughout his-

Interesting facts about snakes

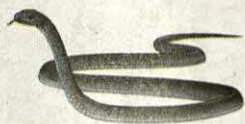
One of the smallest snakes is the Braminy blind snake, which lives in the tropics and grows only 15 centimetres long. It has tiny eyes that are covered by head scales.

An African Gaboon viper in a zoo once fasted for 2½ years. Snakes in zoos sometimes do not eat for 6 months to 3 years.



Gaboon viper

The fastest snake is probably the black mamba of Africa. It was timed moving at the speed of 11 kilometres per hour over a short distance.



Black mamba

The African ball python protects itself from enemies by coiling into a ball with its head in the middle. Many other snakes also use this method of defence.



Ball python

Green tree pythons may be yellow or brown when hatched. Snakes of both colours may hatch from the same batch of eggs. They turn green as they grow older. Green tree pythons live in New Guinea.



Green tree pythons

The ringhals, or spitting cobra, of Africa can squirt venom up to 2.5 metres. The snake aims for the eyes of its enemy. The venom causes a painful, burning sensation and can produce blindness.



Ringhals

tory, snakes have been the subjects of many myths and superstitions. The fear of snakes results from a lack of knowledge about the animals. Most snakes are harmless to people. In addition, snakes are helpful in controlling rats and other rodents.

Some people keep snakes as pets. However, snakes do not move around much and are hard to train. Many kinds stay hidden most of the time. In addition, some snakes have unusual feeding habits, which makes them difficult to care for and keep in good health.

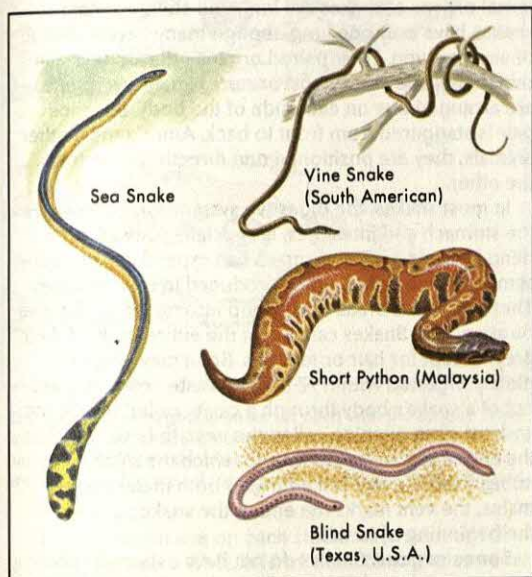
The bodies of snakes

Body shape. Snakes vary greatly in body shape. For example, some snakes, such as the Gaboon viper of Africa, have a stout body. Certain tree snakes, on the other hand, have an extremely thin, long body that resembles a vine. The bodies of sea snakes are flattened from side to side.

The males and females of most species of snakes do not differ greatly in body shape and appearance. How-

How body shape differs among snakes

The illustrations below show some of the variations in the body shape of snakes. The yellow-bellied sea snake is flattened side-ways, and its tail forms an oarlike paddle. Vine snakes have an extremely long, thin body. The Malaysian short python is stubby. The Texas blind snake has a cylindrical body.



ever, among some species, the females are larger than the males. In some other species, the males are larger. One species in which the males and females differ greatly in appearance is the langaha of Madagascar. Male langahas have a conelike stub on the snout. The females have a long snout shaped somewhat like a maple leaf.

Scales and colour. The body of a snake is covered with dry scales, which may be smooth or have ridges. The majority of snakes have overlapping scales that stretch apart. Among most species, the belly scales, which are called *scutes*, consist of one row of large scales extending from the neck to the tail. The side and back scales vary in size and shape among different species.

The scaly skin of a snake has two layers. The inner layer of skin consists of cells that grow and divide. The cells die as they are pushed upward by new cells. The dead cells form the outer layer of skin. From time to time, a snake sheds the outer layer of skin because it becomes worn.

The skin-shedding process is called *moulting*. For a short time before moulting, a snake is less active than usual. The animal's eyes become clouded and then clear again just before it moults. The snake loosens the skin around the mouth and head by rubbing its nose on a rough surface. The snake then crawls out of the old skin, turning it inside out in the process.

How often a snake moults depends chiefly on its age and how active it is. Young snakes shed more often than old ones. Snakes that live in warm climates are active for longer periods than those that live in cooler climates. As

a result, they moult more frequently. Some pythons of the tropics shed six or more times a year. In contrast, some North American rattlesnakes average two or three moults a year. A new segment may be added to the rattle on the tail each time they moult.

A snake's colour comes chiefly from special *pigment cells* in deep layers of the skin. But some colour may be due to the way light is reflected from the surface of the scales.

Most snakes have a drab colouring that matches their surroundings. For example, the North American copperhead has brown bands that blend with the dead leaves on the forest floor where it lives. Some snakes have bright colours. For example, the paradise tree snakes of Southeast Asia have bright red spots. In some cases, snakes of the same species have different colour patterns. For example, some California king snakes are black with white bands across the width of the body. Others have white stripes that extend the length of the body. Some species of ground snakes have a wide variety of markings. Some are tan or brown with many red bands, and some have a red band only around the neck. Others have a red stripe down the middle of the back. Still others are solid tan or brown, without any markings.

Skeleton. The main parts of a snake's skeleton are (1) the skull, (2) vertebrae, and (3) ribs. A few snakes, such as blind snakes, boas, and pythons, have *vestiges* of hind legs or hipbones. A vestige is a remaining trace of a body part that an animal has lost during its development through the ages. Snakes that have vestiges of hind legs or hipbones clearly show their close relationship to lizards.

Skull. The bones of a snake's skull are loosely connected. But the brain is completely enclosed by bone.

In most snakes, the lower jaw has two bones connected at the chin by an elastic tissue. These bones can be stretched widely apart. The lower jaw is loosely attached to the upper jaw. Several bones of the upper jaw and roof of the mouth also are loosely joined to one another and to the rest of the skull. The two sides of a snake's jaws can be moved separately. Some bones of the lower and upper jaws have pointed teeth that curve back toward the throat. These teeth are not suitable for



A snake sheds its skin by rubbing its nose on a rough surface, which loosens the skin about the head. It then crawls out of the skin. This snake is a North American rainbow water snake.

chewing, and so snakes swallow their prey whole. Most snakes also eat their prey while it is alive.

The structure of their jaws enables most snakes to open the mouth wide and swallow animals that are larger than their own head. Some large pythons can swallow animals that weigh more than 45 kilograms. To swallow an animal, a snake moves first one side of its jaws forward and then the other side. The snake's curved teeth stick into the prey and prevent it from escaping. As the snake alternately draws each side of its jaws backward, it pulls the animal toward the throat. A large amount of saliva is produced in the snake's mouth and throat, which eases the passage of the animal.

In some cases, a snake may take more than half an hour to swallow an animal. A special feature prevents the windpipe from being blocked while the snake's mouth and throat are full. The windpipe can be pushed forward over the tongue and out the mouth so that the snake can breathe while swallowing.

Vertebrae. The backbone of snakes consists of an unusually large number of vertebrae. Snakes have about 150 to over 430 vertebrae, depending on the species. Strong, flexible joints connect the vertebrae and enable the body to make a wide range of movements, including rolling into a ball.

Ribs. A pair of ribs is attached to each vertebra in front of the tail. The ribs are not joined together along the belly and so can be extended outward. After a snake has swallowed a bulky meal, the ribs thus spread out as the stomach expands.

Muscles. As many as 24 small muscles are attached to each vertebra and rib in a snake's body. These mus-

cles connect one vertebra to another, the vertebrae to the ribs, one rib to another, and the ribs to the scales. Snakes use most of these muscles to move about. The section *Methods of movement* describes the ways in which snakes move.

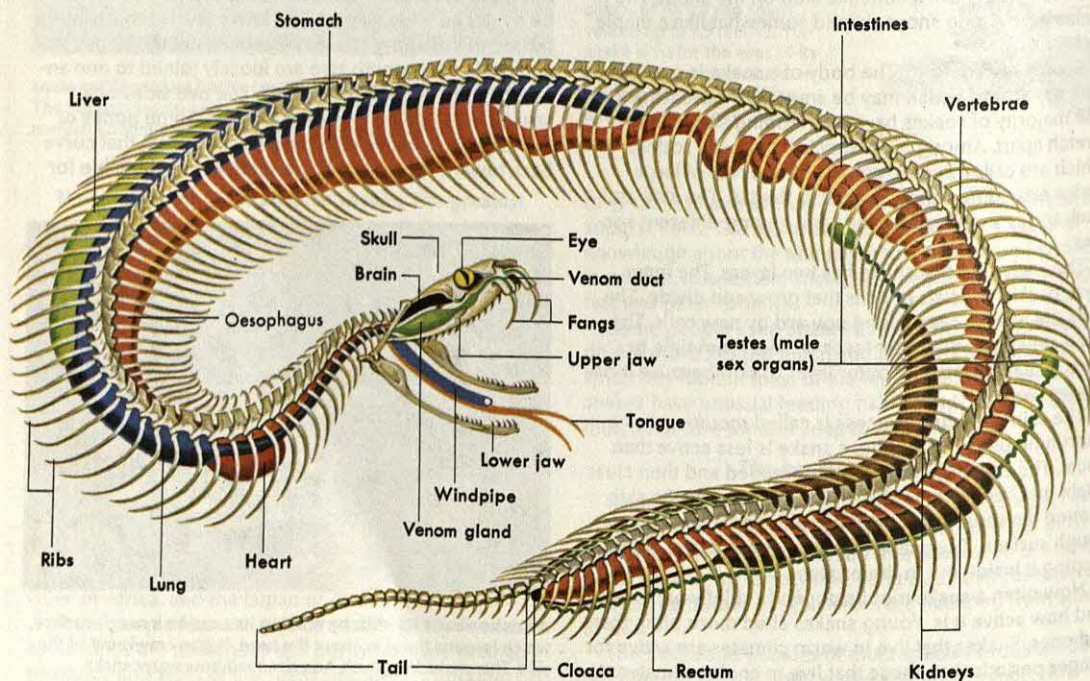
Internal organs. The lung, liver, and other major internal organs of snakes are long and slender. Most snakes have only one lung, though many have a vestige of another lung. Their paired organs—the kidneys and ovaries (female sex organs) or testes (male sex organs)—are arranged one on each side of the body. But each pair is staggered from front to back. Among most other animals, they are positioned one directly across from the other.

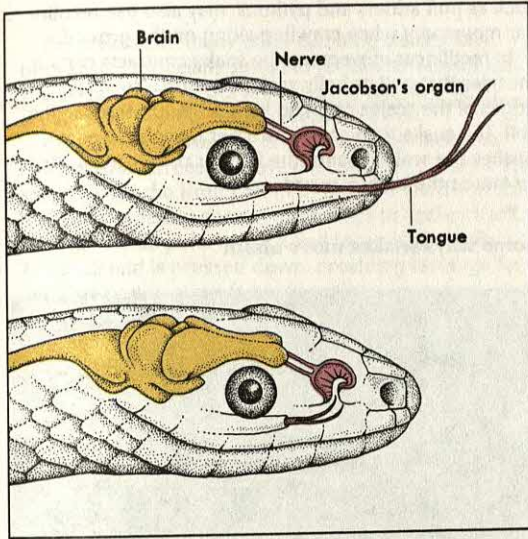
In most snakes, the digestive system, which includes the stomach and intestines, is specially suited for handling bulky food. The stomach can expand greatly. Substances called *enzymes* are produced in the intestines. These enzymes break down food into materials that can be absorbed. Snakes can digest the entire body of their prey, except for hair or feathers. Bone may be completely digested within 72 hours. Waste products pass out of a snake's body through a cavity called the *cloaca* and out of an opening called the *vent*. In female snakes, the cloaca is also the cavity into which the *oviducts* (tubes from the ovaries) empty. In both males and females, the vent marks the end of the snake's trunk and the beginning of its tail.

Sense organs. Snakes do not have especially keen senses of sight or hearing. They rely mainly on special sense organs to provide them with information about their environment.

The anatomy of a snake

This drawing of a male water moccasin shows the skeleton and internal organs. A snake's skeleton consists of a skull and many vertebrae and ribs. Most of the animal's internal organs are long and thin. Only poisonous snakes have fangs and venom glands.





The Jacobson's organ in snakes is used with the tongue to detect odours. The snake flicks out its tongue and picks up scent particles, *top*. When the snake pulls in its tongue, the particles are transferred to the odour-sensitive Jacobson's organ, *bottom*.

Snakes have an eye on each side of the head, which gives the animals a wide field of view. Clear scales cover the eyes. The scales are shed and replaced each time a snake moults. Snakes can easily see movements. But they cannot focus their eyes well, and they have good vision for only a short distance.

Snakes lack outer ear openings. However, they have inner ears and can hear a limited range of sounds carried in the air. Certain bones in a snake's head respond to sound waves and transmit them to the inner ear.

A snake's tongue has few taste buds. The tongue is used with an organ of smell called the *Jacobson's organ*. The Jacobson's organ, along with the nostrils, provides snakes with a keen sense of smell. The Jacobson's organ consists of two hollow sacs in the roof of a snake's mouth. The sacs have many nerve endings that are extremely sensitive to odours. A snake sticks out its tongue to pick up scent particles in the air or on the ground or some other surface. When the snake pulls its tongue back into the mouth, these particles enter the Jacobson's organ. The organ enables a snake to follow the scent trail of its prey. In addition, a male snake can follow the trail of a female snake by using its tongue and Jacobson's organ.

Certain snakes have special heat-sensitive *pit organs*. Pit vipers have two pit organs, one on each side of the head between the eye and nostril. Some boas and pythons have many pits along the lip of the upper jaw. Pit organs enable a snake to detect the exact location of another animal by the body heat it gives off. Thus, the snake can accurately direct its strike at warm-blooded prey even in the dark. A snake with pit organs can sense a change in temperature near its head of less than 0.5°C .

Researchers have found it difficult to test the intelligence of snakes. The animals are hard to train, partly because they have irregular feeding habits and so cannot be rewarded easily with food for performing correctly.

In the few intelligence experiments that have been conducted, snakes showed little learning ability. However, most of the experiments did not test abilities that were important to the snakes' way of life. For example, the ability to learn mazes might be useful to burrowing snakes. But burrowing snakes were not used in the experiments that tested this skill.

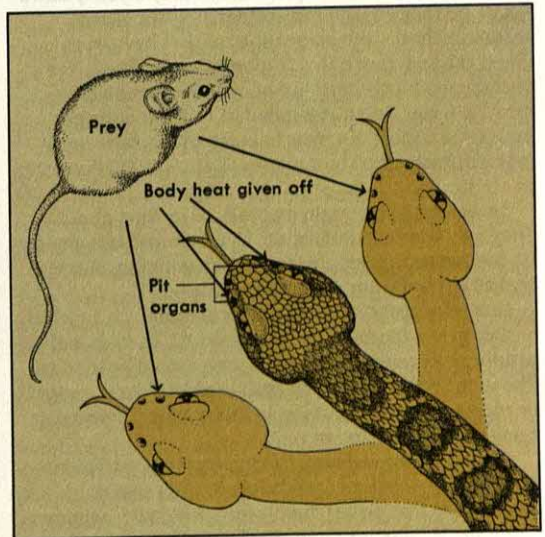
Fangs and venom glands. Only poisonous snakes have fangs and venom glands. Venom glands developed from *salivary glands* (glands that produce saliva). Poisonous snakes bite a victim with their fangs and inject venom into the wound. They use their fangs and venom chiefly to kill prey. In addition, enzymes in the venom speed up the digestion of the animal eaten.

Some groups of snakes have fangs in the front of their mouth. Other groups use their back teeth as fangs. Most poisonous snakes are front-fanged. The two teeth closest to the front of the mouth in the upper jaw form hollow fangs. The fangs are similar to hypodermic needles and may be shed and replaced several times a year. A narrow tube connects each fang to a venom gland on each side of the upper jaw.

The fangs differ between the two main groups of poisonous snakes—*vipers* and *elapids*. Vipers, which include copperheads and rattlesnakes, have long, movable front fangs. When not in use, the fangs fold back into a sheath on the roof of the mouth. When the snake strikes, the fangs are erected. Elapids, which include cobras and coral snakes, have short front fangs that are fixed in place. Sea snakes have the same type of fangs that elapids have.

Some venomous snakes have one to three grooved fangs on the upper jaw in the rear of the mouth. Most of these rear-fanged snakes are not dangerous to human beings because they cannot inject venom rapidly into large animals.

A snake's venom glands produce a number of en-



Pit organs enable a snake to locate prey by the body heat the animal gives off. As the snake moves its head from side to side, the pit organs detect changes in the air temperature. The snake can accurately direct its strike even in the dark.

zymes and other substances that can cause death. After a snake bites its prey, some of these enzymes begin the process of digestion even before the snake begins to swallow the animal. However, the snake usually waits for the venom to kill the animal before swallowing it.

In addition to enzymes, most snake venoms contain two kinds of poisons—*neurotoxins* and *haemotoxins*. Neurotoxins affect the nervous system. They cause difficulties in breathing and swallowing and disrupt the work of the heart. Haemotoxins damage blood vessels and body tissues. Sea snakes have an unusual type of venom that directly affects the muscles.

There is no easy way to distinguish all poisonous snakes from nonpoisonous ones. A person must either recognize the features of specific species or see whether the snake has fangs. For information on the treatment of snakebites, see the article **Snakebite**.

Ways of life among snakes

Snakes are difficult to observe in their natural surroundings because they stay hidden much of the time. Little is known about the ways of life among many species. Scientists who study snakes and other reptiles and amphibians are called *herpetologists*. They have detailed information about the behaviour of only a few species of snakes.

In general, the life of a snake consists mainly of moving about alone in search of food or a mate. Most snakes are active during the day. Others move about at night and rest during the day. Snakes are sometimes inactive for long periods because of cold or hot weather or a scarce supply of food. Some snakes stay within a very limited area. For example, a study of prairie rattlesnakes showed that the males roamed an area about 1.2 kilometres in diameter. The females roamed an area about 0.27 kilometre in diameter.

Methods of movement. Snakes often appear to slither swiftly across the ground. But they actually move slowly compared with many other animals. Garter snakes, pythons, and some other snakes have been timed at a speed of only 1.5 kilometres per hour. The fastest speed on record is that of an African black mamba. It was timed at a speed of 11 kilometres per hour over a short distance. In comparison, human beings can easily run short distances at 16 to 24 kilometres per hour.

Snakes have four main methods of moving about. They are (1) lateral undulation, (2) rectilinear movement, (3) concertina movement, and (4) sidewinding. Some snakes also move in other, unusual ways.

Lateral undulation is the most common way in which snakes move about. The snake flexes its muscles and so produces a series of horizontal waves from head to tail. The loops of its body push against plants, rocks, twigs, or rough areas on a surface. In this manner, the snake's body is propelled forward.

All snakes can swim by producing the wavelike motions typical of lateral undulation. But sea snakes have a body shape that makes them especially good swimmers. The body is flattened from side to side, and the tail forms an oarlike paddle.

Rectilinear movement is also known as creeping. Snakes often use this method to climb trees or move through narrow burrows. Many thickbodied snakes,

such as puff adders and pythons, may also use rectilinear movement when crawling along on the ground.

In rectilinear movement, the snake contracts certain muscles that pull its belly scales forward. The back edges of the scales catch on bark or rough areas in the soil. The snake then contracts other muscles, which pushes the scales against the bark or rough areas and so moves the body forward.

Some ways snakes move about



In **lateral undulation**, a snake moves its body in a series of horizontal waves. Snakes make these wavelike motions to move on the ground or, like the banded sea snake above, to swim.



In **rectilinear movement**, the snake's body is kept straight. The snake crawls by pulling its belly scales forward and then pushing them backward. This snake is an African puff adder.



In **sidewinding**, a snake uses its head and tail as supports and lifts its trunk sideways. This North American sidewinder leaves distinctive tracks as it moves across the sand.

Rat snakes and many other climbing snakes have belly scales especially suited to rectilinear movement. The edges of the scales are squared, and they easily catch on bark as the snake creeps up a tree.

Concertina movement is often used by snakes to climb through trees or move over smooth surfaces. The snake moves the front part of its body forward and coils it slightly, pressing against the surface to anchor itself. The snake then pulls its back end forward and coils it. The back end is pressed down, providing leverage for the front part to move forward again.

Sidewinding is used chiefly by certain snakes that live in areas with loose soil or sand. These snakes include the sidewinder of North America and the carpet viper and horned viper of Africa. In sidewinding, the snake's head and tail serve as supports. The snake lifts the trunk of its body off the ground and moves it sideways. The snake then moves its head and tail into position with the rest of its body. It then repeats the sequence.

Unusual ways of moving. Many small species of snakes seem to "jump" when trying to escape from danger. They hurl the body forward or to the side by rapidly straightening up from a coiled position. Two gliding snakes of southern Asia can "parachute" from a high limb to a lower one or from one tree to another. They spread their ribs, which flattens the body and so helps slow the fall.

Reproduction. All snakes reproduce sexually. In sexual reproduction, a *sperm* (male sex cell) unites with an *egg* (female sex cell), forming a *fertilized egg*. The fertilized egg develops into a new individual.

Male snakes have a pair of sex organs called *hemipenes*. They lie inside the tail and can be pushed out through the vent. During mating, the male curls his tail under the female's, inserts either hemipenis into her cloaca, and deposits sperm. Among some species, the sperm can live within the female's body from several months to more than a year. Thus, the eggs may become fertilized long after mating occurs. Male and female snakes do not stay together after mating.

In regions that have warm summers and cold winters, most snakes mate in the spring or autumn. In the tropics, snakes may mate at any time of the year.

Most snakes lay eggs. The females generally lay them in shallow holes, rotten logs, tree stumps, or similar places. Sometimes, 100 or more females will lay their eggs at the same site. The number of eggs a female lays at one time varies greatly among different species. In many species, the female lays 6 to 30 eggs at a time. Large pythons usually lay about 50 eggs, but they occasionally produce more than 100.

Most female snakes leave their eggs after laying them. But among a few species, including Indian pythons and king cobras, the females may coil on top of their eggs and guard them. Large pythons are the only snakes that incubate their eggs. The female python curls her body around the eggs and contracts her muscles to produce heat if the temperature is cool. In this way, she is able to keep her eggs as warm as 29° C, which aids in hatching them.

The shells of snake eggs are leathery and expand as the young grow inside. The young snakes hatch in about 8 to 10 weeks. The females of some species carry their eggs within the body several weeks before laying them.



Snakes hatching from eggs. Among most species of snakes, the young hatch from eggs outside the mother's body. The snakes shown above are pine snakes.



A female snake giving birth to live young. About a fifth of all species of snakes bear live young. The mother and newborn above are copperheads.

As a result, the eggs are well developed by the time they are laid and hatch within 2 to 4 weeks. When they are ready to hatch, young snakes slash their shells with a special tooth that grows on the upper jaw. The tooth is shed after the snakes crawl out of their shells.

About a fifth of all species of snakes bear live young. The pregnancy period among most of these species lasts about two or three months. Some species may have more than 100 young at a time, but most bear far fewer than that.

Newly hatched or newly born snakes are entirely on their own and must find their own food. They grow rapidly. The young of some species reach maturity—that is, are able to reproduce—in one year. Among other species, the young mature in two to four years. Most snakes continue to grow after reaching maturity.

Regulation of body temperature. The body temperature of snakes varies with changes in the temperature of their surroundings. However, a snake's body temperature must be kept within a certain range for the animal to survive. Most snakes can be fully active only if their body temperature measures between 20° and 35° C. They cannot move if their temperature drops below about 4° C. On the other hand, most snakes will die if they are exposed to temperatures above 40° C.

Snakes maintain their body temperature within the necessary range by moving to warmer or cooler spots.

How a snake swallows its prey

The pictures below show a snake eating a mouse. The snake begins to swallow the mouse headfirst, *top picture*. Its scales stretch apart and its ribs spread out as it swallows the animal. It alternately moves each side of its jaws forward and backward, pulling the mouse through its throat, *centre*. The mouse slides through the snake's oesophagus, *bottom*.



Most of them raise their body temperature by lying in the sun. Snakes that live underground move to warmer areas in the soil. Snakes avoid high temperatures by seeking shelter under bushes, logs, or rocks. Some snakes that live in the tropics spend the hottest part of the year in a state of limited activity called *aestivation*.

Snakes that live in regions with cold winters hibernate and so avoid freezing. They spend the winter in caves, holes in the ground, or other frost-free places. In most areas of the world, a snake sheltered 90 centimetres below the surface of the ground would be protected from freezing. During hibernation, a snake's body temperature may measure from about 4° to 5° C.

Hundreds of snakes of different species may hibernate in the same place if suitable sites are scarce. In the autumn and spring, they may be seen near their hibernating sites warming themselves in the sun.

Feeding habits. Most snakes eat birds, fish, frogs, lizards, and such small mammals as rabbits and rats. Some snakes, including Asian king cobras and North American king snakes, eat other snakes.

Numerous snakes have highly specialized feeding habits. For example, some species eat chiefly snails. The teeth and lower jaw of some snail-eating snakes are specially adapted for pulling the snails from their shells. Thread snakes, which closely resemble blind snakes, have a tiny mouth and eat mainly termites. These snakes can suck the insides of the abdomen from a termite's body, leaving the less digestible parts. Certain snakes that eat eggs have long spines inside the throat on the neck vertebrae. After a snake swallows an egg, the shell is pierced by these spines and then crushed by the snake's muscle contractions. The contents of the egg pass through the throat, but the vertebral spines prevent the passage of the shell, which the snake then spits out.

Snakes have various ways of capturing prey. They may wait in ambush, stalk the animal, or pursue it. When a snake strikes, it lunges toward the animal with its mouth wide open. A snake's strike usually is effective only up to a distance equal to one-half to two-thirds of its body length.

Most snakes swallow their prey alive. However, poisonous snakes generally wait for their venom to kill an animal before they swallow it. Usually, *constrictors* also kill their prey before eating it. Constrictors include boas, bull snakes, king snakes, pythons, and rat snakes. A constrictor wraps two or more loops of its body around a victim and then contracts its muscles, squeezing the animal. A number of people believe that constrictors kill by crushing the bones and internal organs of their victims. Actually, constrictors kill animals by causing them to suffocate.

After feeding, a snake may lie in the sun. The warmth raises its body temperature, which speeds up the process of digestion. A meal may last a snake a long time. Snakes in zoos and laboratories sometimes do not eat for many months. Large snakes, such as boas and pythons, commonly go without food for more than a year. Even some small snakes may fast for periods of 6 to 12 months.

Snakes can survive a long time without food for several reasons. Unlike warm-blooded animals, snakes do not need much food energy to maintain a steady body temperature. Snakes also may remain inactive for ex-

Poisonous snakes



Banded krait
Bungarus fasciatus
1 to 2 metres long
Asia



King cobra
Ophiophagus hannah
3 to 5 metres long
Asia



Saw-scaled viper
Echis carinatus
0.40 to 0.70 metre long
Africa and Asia



Eastern cottonmouth
Agkistrodon piscivorus piscivorus
0.75 to 1.20 metres long
North America



Taipan
Oxyuranus scutellatus
3 to 4 metres long
Australia



Asp viper
Vipera aspis
0.45 to 0.75 metre long
Europe



Boomslang
Dispholidus typus
1.5 to 2 metres long
Africa

Nonpoisonous snakes



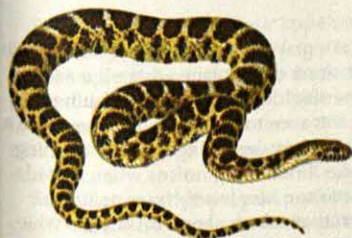
Paradise tree snake
Chrysopelea paradisi
1 to 1.5 metres long
Southeast Asia



Boa constrictor
Constrictor constrictor
3 to 5 metres long
Central and South America



Carpet python
Morelia spilotes
2 to 4 metres long
Australia



Bull snake
Pituophis melanoleucus sayi
1.25 to 1.85 metres long
North America



Corn snake
Elaphe guttata guttata
0.75 to 1.20 metres long
North America



Northern water snake
Nerodia sipedon sipedon
0.60 to 1 metre long
North America



The **Aesculapian snake** lives in Central and Southern Europe. It is named after the Roman god of healing, Aesculapius, who is depicted leaning on a staff around which a large snake is coiled.



The **iridescent earth snake** is a primitive burrowing python from Southeast Asia.



The **green python** lives in the rainforests of northeastern Australia and New Guinea. It feeds mainly on birds.



A **hissed European bush viper** sheds its skin. This venomous snake is found only in the mountains of Tanzania, East Africa.



The **rubber boa** is a burrowing snake with leathery skin. It lives in western North America.

tended periods and so use up little energy. In addition, snakes have extensive tissues that store fat. During long fasts, they live off this fat.

Protection against enemies. Many kinds of animals prey on snakes. These predators include large birds, such as hawks and serpent eagles; certain mammals, such as mongooses and pigs; and certain other snakes, such as king cobras and king snakes.

Snakes have a wide variety of defences against predators. Many species have colour patterns that match their surroundings and so help conceal them. If threatened

by a predator, a snake may escape simply by flexing into a burrow, pond, or some other place where the animal cannot follow. Some shield-tailed snakes of southern Asia can block the entrance to their burrow. They have a short, blunt tail, which they wedge against the opening.

Many snakes make threatening noises when a predator approaches. Some can hiss loudly by expelling air from the lung. The rattlesnake makes a distinctive whirring sound by vibrating its tail rattle. The African saw-scaled viper produces a rasping sound by rubbing its side scales together.



A yellow-headed thread snake, from the West Indies, lives under bark and feeds mainly on ants and termites.



Sea snakes are most numerous in the warm waters of the Indian and Pacific oceans. Shown above is an olive sea snake.



A grass snake constrains a toad, which puffs it self up with air to make it appear larger.



The black mamba is a highly venomous snake which lives in sub-Saharan Africa.



The green vine snake is an extremely slender snake found in forested areas of Central and South America. It feeds mainly on lizards and birds.

Some snakes change their appearance and adopt a threatening posture that may frighten away predators. For example, the cobra lifts its neck and spreads its ribs, forming a broad hood. North American hognose snakes, indigo snakes, and some other species spread the neck ribs and inflate the lung, which makes them look larger and fiercer.

Many animals that prey on snakes have no interest in dead snakes. Thus, certain snakes defend themselves by playing dead. The North American hognose snake is especially well known for such behaviour. The African bull

python protects itself by coiling into a tight ball with its head in the middle. This defence is also used by North American ground snakes, rubber boas, and various other species.

Some harmless snakes resemble poisonous snakes and thus may gain protection from enemies that fear poisonous snakes. In addition, some kinds of harmless snakes imitate the behaviour of poisonous snakes. For example, king snakes and rat snakes vibrate the tail among dry leaves and thereby produce a sound like that made by rattlesnakes. Some harmless snakes of Africa

imitate the rasping sound of the saw-scaled viper by rubbing their side scales together. Certain harmless Asian snakes spread their ribs and form a hood like that of the Indian cobra.

If other defences fail, a snake might attack and bite an enemy. The bite of a poisonous snake is an especially powerful weapon. But the snake could be seriously clawed or bitten before its venom takes effect. The African "spitting" cobra has added protection. It can squirt venom into the eyes of an enemy 2 to 2.5 metres away. The venom causes an immediate painful, burning sensation and can produce blindness. Large constrictors are also a powerful match for most of their enemies. They can quickly coil around an animal and suffocate it, just as they do prey.

Battles among male snakes. Among some species of snakes, the adult males sometimes fight one another. In a typical battle, two snakes rear up, entwine their bodies, and try to push each other down. The combat continues until one snake gives up and retreats. Such battles are especially common among vipers. But they also occur among such small, harmless snakes as North American ground snakes and European smooth snakes.

Herpetologists do not know for certain why male snakes of some species fight one another. But most of the fights occur during the breeding season. They may be caused by rivalry over a mate or feeding area.

Life span. Herpetologists do not know how long snakes live in the wild. Most snakes in zoos do not live longer than 15 years. But some have lived 20 years in captivity, and a few have lived over 30 years.

Classification of snakes

There are about 2,700 species of snakes. They are classified into various families, based chiefly on common skeletal features. Most herpetologists divide snakes into 12 families. The common names of these families are (1) colubrids, (2) blind snakes, (3) primitive blind snakes, (4) thread snakes, (5) boids, (6) elapids, (7) sea snakes, (8) vipers, (9) shield-tailed snakes, (10) pipe snakes, (11) sunbeam snakes, and (12) elephant trunk snakes. The scientific name of each family of snakes is given in parentheses after the common name.

Colubrids (Colubridae) total about 2,000 species. They make up about two-thirds of all species of snakes. The family includes most of the common harmless snakes, such as the North American garter snakes and rat snakes. It also includes many species of venomous, rear-fanged snakes. However, only a few rear-fanged snakes, such as the African bird snakes and boomslangs, are dangerous to human beings.

Colubrids live throughout most of the world. The different species vary greatly in appearance and ways of life. They dwell on land, in trees, in water, or under the ground.

Blind snakes (Typhlopidae) consist of about 200 species. They burrow underground and eat mainly ants and termites. Blind snakes look much like earthworms, though some species grow to about 90 centimetres long. Their eyes are covered by the head scales. Most blind snakes live in tropical and subtropical regions.

Primitive blind snakes (Anomalepididae) are small wormlike snakes that live in leaf litter on the floor of rain forests in Central and South America. They eat small in-

sects and worms. They are closely related to blind snakes. There are about 20 species known.

Thread snakes (Leptotyphlopidae) make up about 50 species. They closely resemble blind snakes and have similar ways of life. A main difference between the two families is that blind snakes have teeth only on the upper jaw, and thread snakes have teeth only on the lower jaw. Thread snakes live in Africa, southern Asia, southwestern North America, and tropical areas of Central and South America.

Boids (Boidae) include the largest snakes—the anacondas, pythons, and boas. The family consists of about 100 species, most of which have large, stout bodies. However, some species are less than 90 centimetres long. Most boids have external vestiges of hind legs. The majority of boids live in tropical and subtropical regions. Different species dwell on land, in trees, or in water.

Elapids (Elapidae) consist of nearly 200 species of venomous snakes. All have short, nonmovable front fangs. No elapids live in Europe, and coral snakes are the only members of the family found in North and South America. Elapids are most numerous in Australia, where they include the Australian black snake, death adder, taipan, and tiger snake. The cobras of Africa and Asia, the kraits of southern Asia, and the mambas of Africa also are elapids. Most elapids dwell on land.

Sea snakes (Hydrophiidae) consist of 50 to 60 species of venomous snakes. They are related to elapids. Most sea snakes are 90 to 120 centimetres long. In all species, the body is flattened sideways.

Most sea snakes live in the tropical areas of the Indian and Pacific oceans. They dwell in coastal waters and are rarely found at depths greater than 46 metres. Occasionally, huge groups of sea snakes are spotted in the open sea. Scientists believe that the snakes may be massed together by tidal currents. No sea snakes dwell in the Atlantic Ocean, the Mediterranean Sea, or the Red Sea.

Most sea snakes give birth to live young in the water. However, a few species come ashore and lay eggs.

Vipers (Viperidae) have long fangs attached to the front of the upper jaw. The upper jaw rotates, enabling a viper to move its fangs forward and backward.

The fangs of vipers are much longer than those of elapids. The African Gaboon viper has perhaps the longest fangs of any venomous snake. They may grow up to 5 centimetres long.

Vipers are divided into two main groups—*pit vipers* and *true vipers*. The pit vipers have pit organs between their eyes and nostrils. Pit vipers consist of about 100 species, which are found on all the continents except Antarctica and Australia. They include North American copperheads, rattlesnakes, and water moccasins. True vipers do not have pit organs. They consist of about 50 species, which live in Africa, Asia, and Europe. True vipers include the Gaboon viper and the European viper.

Shield-tailed snakes (Uropeltidae) consist of about 45 species of burrowing snakes, all of which live in Sri Lanka and southern India. They have a highly pointed or wedge-shaped snout; a short, blunt tail; and smooth scales. Most species of shield-tailed snakes dwell in humid mountain forests.

Pipe snakes (Aniliidae) make up about 12 species of burrowing snakes. They have a stout body and short tail.

They grow less than 90 centimetres long and live in southern Asia and South America.

Sunbeam snakes (Xenopeltidae) consist of one species. The snakes live in southeastern Asia. They have highly polished scales, which sparkle in the sunlight. They usually stay under logs or stones or in burrows during the day and move about at night.

Elephant trunk snakes (Acrochordidae), also called file snakes, consist of two species. They have a stout body and wrinkled skin. These snakes grow up to 2.5 metres long and are widely hunted for their leatherlike skin. They live in the rivers and coastal waters of southern Asia, northern Australia, and the South Pacific islands.

The importance of snakes

The main value of snakes is that they form part of the environment and help preserve the balance of nature (see **Balance of nature**). But people also gain economic benefits from snakes. The animals aid farmers by preying on such pests as mice and rats. In some countries, especially China and Japan, people eat the meat of snakes. The skin of boas, elephant trunk snakes, and pythons is used to make such items as belts and handbags. This use of snake skins has endangered many species of snakes. Several countries now have laws to prevent the importation of such items.

Snake venom has several uses in medicine and biological research. *Antivenin*, which is used to treat snakebite, is prepared from the blood serum of horses that have been injected with venom. Certain pain-killing drugs are prepared from neurotoxins in venom. Researchers use the powerful enzymes in venom to break down complex proteins for biochemical studies.

In general, snakes are abundant in most parts of the world. But human beings have caused a decline in the numbers of some species, partly through overhunting and by needlessly killing them. People also destroy the places where snakes live by clearing land for farms, houses, and industries. Human activities threaten the survival of a few species, including the Indian python, the Jamaica boa, and the San Francisco garter snake.

Scientific classification. Snakes belong to the order Squamata in the class Reptilia. They form the suborder Serpentes, also called Ophidia.

Related articles in *World Book* include:

Kinds of snakes

Adder	Cobra	Milk snake
Anaconda	Copperhead	Python
Asp	Coral snake	Rattlesnake
Blacksnake	Fer-de-lance	Tree snake
Boa constrictor	Garter snake	Viper
Brown snake	Gwardar	Water moccasin
Bushmaster	King snake	Whip snake
Carpet snake	Mamba	

Other related articles

Herpetology	Snake charming
Reptile	Snakebite

Outline

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| A. Body shape | E. Internal organs |
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| C. Skeleton | G. Fangs and venom glands |
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II. Ways of life among snakes

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| A. Methods of movement | E. Protection against enemies |
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III. Classification of snakes

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| A. Colubrids | G. Sea snakes |
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| C. Primitive blind snakes | I. Shield-tailed snakes |
| D. Thread snakes | J. Pipe snakes |
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| F. Elapids | L. Elephant trunk snakes |

IV. The importance of snakes

Questions

- What kind of fangs do vipers have?
- Why can snakes survive a long time without food?
- How do snakes swallow their prey?
- What is the most common way that snakes move about?
- How have human beings caused a decline in the numbers of some species of snakes?
- How do most snakes raise their body temperature?
- What is the Jacobson's organ? How is it used?
- To what family do most species of snakes belong?
- How do constrictors kill their prey?
- How many species of snakes are there?

Snake charming is an ancient form of entertainment in northern Africa, and in India, Pakistan, and other parts of southern Asia. A snake charmer usually uses a cobra. The charmer sits before the snake, playing a flute-like instrument and swaying to and fro. The cobra slowly raises its head and neck and follows the charmer's swaying movements. The snake has no external ears or eardrums, and so it cannot hear the music. Instead, it is fascinated by the charmer's rhythmic movements. Snake charmers must understand the habits of snakes. Sometimes they cut out the fangs of poisonous snakes to make them harmless. Some circuses have "charmers" who handle harmless boa constrictors or pythons.

Snake River is the chief branch of the Columbia River, in the U.S.A. It rises in Wyoming near the Continental Divide in Yellowstone National Park. The river then flows south through Grand Teton National Park. It bends west and flows across the Snake River Plains of southern Idaho. Irrigation projects, dams, and falls provide water for power and irrigation.

The Snake River turns north at the Oregon border. It forms part of the boundary between Idaho and Oregon. At Lewiston, Idaho, the Snake turns west and flows through southeastern Washington. Boats can use the Columbia and Snake rivers from the Pacific Ocean inland to Lewiston. Lewiston and nearby Clarkston, Washington, are important ports for grain and wood products exports. The Snake joins the Columbia near Pasco, Washington, 1,670 kilometres from its source.

Snakebird. See **Anhinga**; **Wryneck**.

Snakebite. Snakes are naturally shy animals and only bite people if disturbed or trodden on by mistake. Thus, most snakebites are on the foot or lower leg, with few on the arm or hand.

The treatment of a snakebite depends on whether the snake concerned was poisonous. A poisonous snakebite requires urgent medical attention. Poisonous snakes have hollow fangs through which they inject *venom* (poison) into the victim's body. The fangs may leave characteristic puncture marks in the skin. Often, however, these marks are absent. By comparison, a non-

poisonous snake generally leaves only a group of surface bites which in some cases appears to have a horse-shoe shape.

If the snake is nonpoisonous, the area of the snakebite should simply be washed thoroughly with soap and water. But since it is not always easy to tell whether a victim has received a poisonous snakebite or not, urgent medical treatment should always be sought.

Poisonous snakebites require complicated medical treatment. Doctors in some areas of the world discourage the washing of the skin near a poisonous snakebite because traces of the venom can help the doctor identify the species concerned and select the right *antivenom* to apply to reduce the effects of the snake poison.

The first step in treating the victim of a poisonous snakebite is to call the doctor immediately. If the doctor's surgery, office, or hospital is nearby, the victim must be transported there straight away. Wherever possible, bring transport to the victim. The victim must be kept as still and quiet as possible, since any movement will help the poison to spread throughout the body. The limb with the bite must be kept below the level of the heart because this may help delay the body's absorption of venom. A bitten leg should, however, be rested on a pillow, while an arm should be placed in a sling. The victim also may need to be treated for shock (see **First aid** [Treat for shock]).

If venom has been injected, the area around the bite is likely to swell within a few minutes of the attack. If swelling does not take place, it is probable that little venom has been injected and the patient should recover quickly. However, the patient must be kept under observation for at least 12 hours.

If swelling does take place, the bitten limb must be prevented from moving by the application of a splint or bandage. A firm, but not tight, bandage should be wrapped around the whole of the bitten limb. This should delay the entry of the venom into the bloodstream. A tourniquet, however, must not be used. A person giving first aid to a snakebite victim must keep the patient calm and make sure he or she moves as little as possible. The first-aider should not cut or suck out the wound, since this may lead to secondary infection or loss of blood. If the victim is not suffering from *nausea* (vomiting or a sick feeling), he or she may be given water to drink. Paracetamol may be given to reduce pain, but aspirin should not be used because it may stop the blood from clotting properly. If the snake that caused the bite has already been killed, it should be taken, without being touched, to the hospital with the patient. Otherwise, it should be left alone in case it bites again.

Snake poisons. There are two main types of poisonous snake: (1) vipers, including true vipers and pit vipers; and (2) elapids, including cobras, coral snakes, kraits, and mambas. Viper bites cause severe pain and reddening and swelling around the wound. Elapid bites tend to cause less initial pain, but later on breathing may be affected and the victim may become drowsy. Sea snakes, which include some of the world's most venomous species, are related to elapids, and their bites have similar, though more drastic effects. Sea-snake bites often go unrecognized. By the time severe symptoms set in, it may be too late to help the victim.

Snakebite serum, or antivenom, is the most effective treatment against snake poisons. The serum chemically reverses the action of the poison in the body. But it must only be administered by those medically trained to do so. Improper use or an incorrect dose can lead to harmful side-effects.



The common black snakeroot produces a medicinal drug.

Snakeroot is the name of several very different flowering plants that grow in prairies and woodlands of North America. These plants all became known as snakeroot because their roots supposedly looked like snakes or because they were used to treat snakebites.

Virginia snakeroot grows in the Eastern United States. It reaches a height of up to 90 centimetres and has brownish-purple flowers. People once chewed its roots and then applied them to wounds. *Texas snakeroot*, also called *serpentary*, has bright-green oval leaves and dark-brown flowers. It was used to make a tonic taken as a stimulant and painkiller.

Scientific classification. Virginia and Texas snakeroot belong to the birthwort family, Aristolochiaceae. Virginia snakeroot is *Aristolochia serpentaria* and Texas snakeroot is *A. reticulata*.

Snapdragon is a group of hardy plants with colourful flowers. Each flower has two lips that open like jaws when the sides of the flower are pressed. Honey bees can force open the lips to obtain nectar. When the pressure is released, the lips snap shut.

The common *snapdragon* is native to the Mediterranean region. There are many cultivated varieties that are popular garden plants. The velvety flowers are 4 to 5 centimetres long and may be a variety of colours. The plant



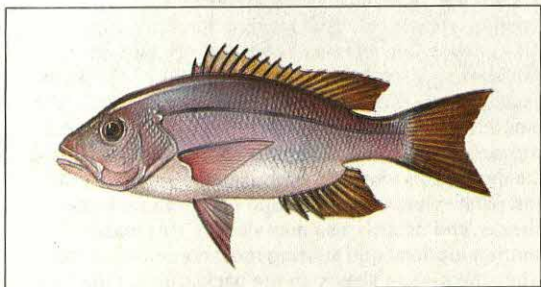
Snapdragon

grows 60 to 90 centimetres tall, but dwarf varieties are smaller. The common snapdragon thrives in full sun. Smaller-flowered species of snapdragons are native to the Pacific coast of North America.

Scientific classification. Snapdragons belong to the figwort family, Scrophulariaceae. They make up the genus *Antirrhinum*. The common snapdragon is *A. majus*.

See also **Flower** (picture: Garden annuals).

Snapper is any of about 185 species of food fishes that live in tropical parts of the Pacific and Atlantic oceans. The snappers of the Western Hemisphere are most common around Florida, the West Indies and the shores of the Gulf of Mexico, and the Caribbean region. In the Pacific, they live chiefly around the tropical coral atolls and the East Indies and Philippines. They live rather close to shore, usually in rocky places.



The snapper lives in warm southern waters. The Caribbean red snapper, above, is common in the Western Hemisphere.

Snappers grow to 60 to 90 centimetres long. They have a high, almost humped, back and are rather flat from side to side. The mouth is large, with strong teeth. The tail is slightly forked. Snappers may be red, greenish, or striped. They often have a black spot on each side of the body. Some snappers, especially the larger species, may become toxic. Eating them can cause a sometimes fatal disease called *ciguatera*.

Scientific classification. Snappers make up the snapper family, Lutjanidae. The Caribbean red snapper is *Lutjanus purpureus*.

Snead, Sam (1912-), an American golfer, has claimed a total of 165 tournament victories. He became known as "Slammin' Sammy" for his powerful drives and naturally smooth swing.

Snead won the United States Professional Golfers' Association (PGA) championship in 1942, 1949, and 1951 and the Masters tournament in 1949, 1952, and 1954. He won the British Open in 1946. Snead finished second in the U.S. Open four times. In 1965, he won the Greensboro Open, becoming the oldest man ever to win a regular PGA tournament.

Samuel Jackson Snead was born in Ashwood, near



Sam Snead

Hot Springs, Virginia. He turned professional in 1934 and won his first important tournament, the Oakland Open, in 1937. In 1980, he joined the U.S. PGA senior tour, limited to golfers at least 50 years of age.

Sneezewort is a hardy perennial plant that grows in damp fields and along roadsides in Europe, Asia, and North America. It is called sneezewort because its strong odour causes some people to sneeze. The plant grows from 30 to 60 centimetres high. It is an overall greyish colour and has dark green long pointed leaves. The flowers are creamy white in a loose flower head. It has loose clusters of small white flowers.

Scientific classification. The sneezewort belongs to the composite family, Compositae (Asteraceae). It is *Achillea ptarmica*.

Sneezing is a sudden and violent rush of air out through the nose and mouth. A person has no control over sneezing. The body takes this action to get rid of irritating or harmful objects in the nose. Sensitive nerve endings that line the nose react to these objects by causing the sneeze.

Sneezing occurs often in an ailment called *hay fever*. Plant pollen lodges in the nose of sufferers and causes the sneeze. Bright sunlight can also cause sneezing because the eye nerves are closely connected with nerve endings in the nose.

Sneezing aids the body, but can be harmful to other people. For example, the nose fills with congestion that contains germs when a person has a cold. Sneezing helps clear the nose. But unless the sneezer covers the mouth and nose, the germs escape into the air and may infect others.

See also **Disease** (Spread of infectious diseases); **Cold, Common; Nose; Hay fever.**

Snell, Peter (1938-), was one of the world's greatest middle-distance runners. In 1962, he set three world records, for the mile (3 minutes 54.4 seconds), 880 yards (1 minute 45.1 seconds), and 800 metres (1 minute 44.3 seconds). He won three gold medals in appearances at two Olympic Games. He won the 800 metres at the 1960 games in Rome. Then, at the 1964 games in Tokyo, he won both the 800 metres and the 1,500 metres. Snell was born at Opunake, in the North Island of New Zealand. He retired from athletics in 1965.

Snipe is the name of a group of shore birds related to sandpipers, curlews, and plovers. The *common snipe*, of Europe, also called *Wilson's snipe*, is about 30 centimetres long. It has a short tail and a long bill. The plumage is dark brown with contrasting light stripes on the crown and back.

The snipe uses the flexible, sensitive tip of its bill to poke about for worms and grubs. This bird performs acrobatics in the air during the mating season. It also makes a strange "bleating" or "drumming" sound by flying to great heights and descending in a series of quick swoops as air rushes through its feathers.

The common snipe is more timid than most sandpipers about being seen in the open by day. It nests in low places in the ground on the edge of marshes. The female lays four olive brown or greyish drab eggs thickly spotted with chocolate colour. The *jack snipe* is a smaller bird, about 19 centimetres long. It is a secretive bird. It has a habit of flexing its legs when it feeds.

Other snipes include the *pintail snipe* of India; and



The snipe nests in low places on the edge of marshes. The common snipe, *above*, has a short tail and a long bill.

the *Japanese snipe*, which breeds on the Kuril Islands near northern Japan. The Japanese snipe spends winters in Australia.

Painted snipes are a completely unrelated group of birds that live in the Southern Hemisphere. See also Curlew.

Scientific classification. Snipes belong to the sandpiper family, Scolopacidae. The common snipe is *Gallinago gallinago*, the pintail snipe is *G. stenura*, the Japanese snipe is *G. hardwickii*, and the jack snipe is *Lymnocyrtes minima*. Painted snipes belong to the family Rostratulidae.

Sniperscope is an electronic device with which a rifle can be aimed accurately in the dark. American scientists developed the sniperscope during World War II (1939-1945) to enable troops to fight more effectively at night. The sniperscope has been replaced by the *starlight scope*, which was invented in 1963 and first used during the Vietnam War. Armed forces and police use starlight scopes not only for night shooting, but also when patrolling dark areas. Troops use the devices on larger



A **starlight scope** mounted on a missile-launcher enables a soldier to aim accurately in the dark. The device magnifies starlight and moonlight reflected by objects in the area.

weapons, such as cannons and missile launchers, as well as on rifles.

A sniperscope sends out infrared rays, which are invisible except when viewed through special devices. The rays are reflected by the objects they strike and are changed into an image in the sniperscope. However, an enemy can locate the source of the rays with an *infrared detector*. Sniperscopes of World War II had a range of only 115 metres, produced an unclear image, weighed 15 kilograms, and were bulky.

A starlight scope picks up starlight and moonlight reflected by objects within the range of the instrument. It magnifies this light electronically within a glass tube. The magnified light is focused on a screen at the back of the tube, where a bright image forms. The smallest starlight scopes weigh only about 0.9 kilogram. Some larger types have a range of up to 1.5 kilometres.

Snooker. See Billiards and snooker.

Snoring is a rough, broken sound made during sleep.

Almost everyone snores occasionally, but men usually snore more often than women and children. Snoring usually takes place when a sleeper breathes through the mouth. Air rushing in through the mouth vibrates the *soft palate*, the soft tissue in the roof of the mouth near the throat. This vibration produces the sound. As the soft palate vibrates, the lips and other mouth tissue, cheeks, and nostrils also may vibrate. This makes the snoring louder. Loud snoring most commonly occurs when the person sleeps on the back, causing the tongue and soft palate to further obstruct the airways.

Many remedies have been tried to stop snoring. The avoidance of alcohol and medications that produce sleep may lessen the tendency to snore. A hundred years ago doctors removed the *uvula*, a tab of soft tissue hanging from the roof of the mouth near the throat. The surgical removal of the uvula, the tonsils, and part of the soft palate can reduce snoring in some people.

Snorkel. See Skin diving; Submarine (The power plant).

Snorri Sturluson (1179-1241) was a great medieval Icelandic poet and historian. His major works were the *Heimskringla* (*Circle of the World*), a history of the kings of Norway from their origins up to his own day, and the *Prose Edda*. He probably also wrote *The Saga of Egill Skallagrimsson*, one of the best Icelandic sagas about a great poet of the 900's who was one of Snorri's forefathers. Snorri was a wealthy and powerful man in Iceland. In his later years, he became involved in a power struggle in Norway that led to his murder on the orders of the Norwegian king.

See also Edda.

Snouck Hurgronje, Christiaan (1857-1936), was the greatest Dutch scholar on Islam. He was also an adviser to the government of the Netherlands East Indies (now Indonesia).

He was born in Oosterhout in the Netherlands. He studied theology and received his doctorate in Semitic languages from the University of Leiden in 1880. In 1884, he travelled to what is now Saudi Arabia to study Islamic law at first hand. He spent almost a year in Jidda and Mecca, where he pretended to be a Muslim, using the name Abdul Ghaffar. In 1889, he travelled to the East Indies, to study Islam there. In 1890, he was appointed adviser on Asian languages and Islamic law there. His first



Snow covers some high peaks in mountainous regions, such as the European Alps, throughout the year. On the lower slopes, the snow melts away during the warmer months.

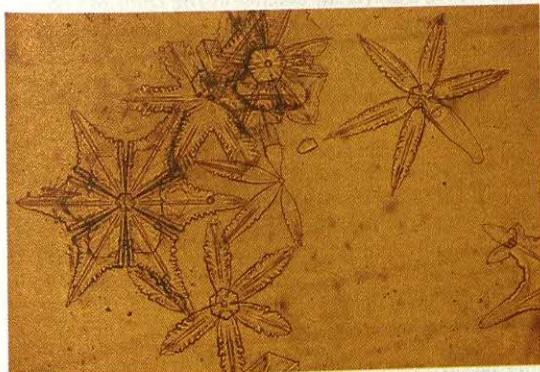
task was to study matters in Aceh, in northern Sumatra. He described his findings in a book called *The Acehnese*. He advised the Netherlands Indies government on the policy to adopt towards the Acehnese, who were in revolt against Dutch rule.

Snow is a form of precipitation that consists of masses of tiny ice crystals. These crystals grow from water vapour in cold clouds. The crystals combine to produce snowflakes as they collide and stick together.

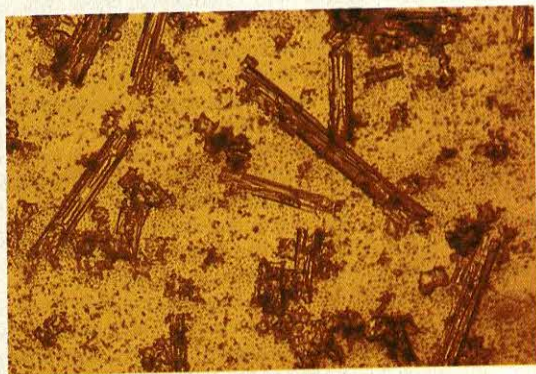
Snowflakes vary widely in size. In some cases, as many as 100 ice crystals may cling together to form a snowflake larger than 2.5 centimetres in diameter.

Basic snow crystal shapes

All snow crystals have six sides and grow in either platelike or columnar patterns, depending on the air temperature and the amount of moisture present. The photos below were taken through filters that make the snow show up against an orange background.



Platelike snow crystals appear as flat, six-sided plates. In humid air, they grow in the shape of six-pointed stars.



Columnar snow crystals resemble long needles of ice. However, high humidity may cause them to become hollow columns.



A snow-covered landscape makes an attractive scene. Ground snow insulates plants, roots, and seeds from harsh frosts, but makes life and food-finding harder for animals and birds that do not hibernate or migrate.

even fall near the equator on mountains higher than 4,880 metres.

Snow is an important source of water. When snow melts in the mountains, it provides water for streams, hydroelectric power plants, and irrigation reservoirs. Snow also serves as a good insulator. Snow helps protect plants and hibernating animals from the cold winter air. However, an excessive build-up on steep, unfor- ested mountainsides may result in dangerous ava- lanches.

How snow forms. In most cases, snow crystals form on microscopic particles, called *ice nuclei*, which are present in clouds with below-freezing temperatures. Snow crystals may develop when water vapour is deposited directly on ice nuclei. They may also form when the ice nuclei cause tiny drops of *supercooled water* to freeze. Supercooled water is water that has remained unfrozen at below-freezing temperatures. However, at temperatures below -40°C , supercooled water freezes without the presence of ice nuclei.

Snow crystals grow in *platelike* and *columnar* pat- terns, depending on air temperature and humidity level. Platelike crystals appear as flat, six-sided plates. But they also grow in the shape of six-pointed stars with a fern- like structure in humid air. Platelike crystals form when the temperature is about -15°C . Columnar snow crys- tals resemble long needles of ice, but high humidity may cause them to become hollow columns. They form when the temperature is about -5°C or when it drops below -20°C . A snow crystal's shape may change from one type to another as the crystal passes through layers of air with different temperatures.

When melted snow crystals or raindrops fall through cold air, they freeze to form small particles of clear ice called *sleet*. Falling ice crystals that collide with super- cooled water droplets become white pellets called *snow pellets* or *graupel*. When such collisions occur repeatedly, the pellets may grow larger and form *hail*.

Record snowfalls. Weather records show that the average annual snowfall worldwide has remained about the same since the last half of the 1800s. In some years it snows only a little, but in others it snows a great deal. Some people mistakenly believe that it snows less today

than it did years ago. Yet, new snowfall records are set almost every year.

Artificial snow. In 1936, Ukichiro Nakaya, a Japanese physicist, produced the first artificial snow in a labora- tory. During the 1940s, Vincent J. Schaefer and several other American scientists developed methods for arti- ficially making snow outdoors. Clouds containing super- cooled water are seeded with artificial ice nuclei, such as silver iodide and metaldehyde crystals. In some cases, such seeding agents as dry ice pellets or liquid propane are used (see *Rainmaking*). Also, special ma- chines are used to produce limited amounts of artificial snow for ski slopes and trails.

See also *Glacier*; *Hail*; *Sleet*; *Snow line*; *Storm*.
Snow, C. P. (1905-1980), was an Englishman of many talents who was most famous as a novelist. He was also a scientist, government official, and lecturer.

Snow's 11-volume series of novels *Strangers and Brothers* (1940-1970) is a study of England's professional class. Lewis Eliot is an important character and the nar- rator in all the novels. Like Snow, Eliot is a man of lower- class birth who works his way into professional life. Eliot appears in many jobs in the series, a device that allows Snow to present a panoramic view of English life. Eliot is a lawyer in *Strangers and Brothers* (1940) and *Time of Hope* (1949), a university teacher in *The Light and the Dark* (1947) and *The Masters* (1951), and a government official in *The New Men* (1954). In *The Sleep of Reason* (1968), Eliot serves as an observer at a murder trial. Col- ourless, almost stodgy, Eliot is nevertheless an impartial, selfless person. To Snow, he is the kind of person needed to make responsible decisions.

Charles Percy Snow was born in Leicester and earned a doctorate in physics from Cambridge University. As a civil service commissioner from 1945 to 1960, he se- lected scientists for government projects. Snow was knighted in 1957. He was parliamentary secretary to the minister of technology from 1964 to 1966. In *The Two Cultures and the Scientific Revolution* (1960), a pub- lished lecture, Snow deplored the lack of communica- tion and of understanding between scientists and non- scientists. In *The Realists* (1978), Snow discussed the life and work of eight important European novelists.



The snow bunting has a snowy white head and breast.

Snow blindness is a temporary decrease in vision caused by bright sunlight reflected from snow. Recovery within 24 hours is usual. Occasionally, a person has trouble distinguishing between colours after snow blindness, and sees everything coloured red for a long time. In most cases, snow blindness disappears when a person rests the eyes and remains indoors. However, in rare cases, prolonged exposure to the reflected light can lead to *solar retinopathy*, a disorder that may result in some permanent loss of vision. Wearing sunglasses or dark goggles helps prevent snow blindness.

Snow bunting is a sparrowlike bird of northern North America. It is mostly white on its head and breast, but its back, wings, and tail are partly black. During the autumn and winter, the head and back feathers are edged with brown. These edges wear off as the winter passes on. The bird turns black and white before it reaches its nesting ground on the tundra in Canada and Alaska. Snow buntings are familiar winter birds in Canada. They go as far south as the United States only when the snow is heavy. Snow buntings spend summers in the Arctic regions.

Scientific classification. The snow bunting belongs to the bunting family, *Emberizidae*. It is *Plectrophenax nivalis*.

Snow leopard, also called *ounce*, is a beautiful member of the cat family. When full-grown, this animal is about 2 metres long. The snow leopard's summer home is as far up as 3,900 metres in the cold Tibetan plateau of



The snow leopard has pale hair and brown spots.

central Asia, from the Altai Mountains south to the Himalaya. During the coldest winter months, the animal goes down into the valleys as low as 1,800 metres.

The snow leopard's heavy hair is pale grey and marked with leopardlike brown spots. Its pale colour helps it to steal unnoticed over the snow. In its native rocky home, the snow leopard feeds on ibex, bharal, marmots, pikas, and other animals. So many snow leopards have been killed for their fur that the species has become endangered.

Scientific classification. The snow leopard belongs to the cat family, *Felidae*. It is *Panthera uncia*.

See also **Animal** (picture: Animals of the mountains).

Snow line is the lower edge of the permanent snow fields found on upper mountain slopes. The location of the snow line depends upon the height of the sun, latitude, winds, temperature, and moisture. The snow line on the same mountain range may change from year to year. In the tropics, the snow line is about 5 kilometres above sea level, and in the subtropics it is about 6 kilometres above sea level. The snow line of the Rocky Mountains of the United States is about 3 kilometres above sea level. In the Alps of Western Europe, it is about 2 kilometres above sea level. It is less than a kilometre above sea level in Greenland. It is at sea level in polar lands.

Snowdon is a mountain in Gwynedd, Wales. The mountain has five peaks—Yr Wyddfa, Crib-y-Ddysgul, Crib Goch, Lliwedd, and Yr Aran. Yr Wyddfa, rising to 1,085 metres above sea level, is the highest peak in Wales and England. Snowdon is surrounded by 2,190 square kilometres of national park called Snowdonia. See also **Gwynedd**.

Snowdrop is the name of a plant in the amaryllis family. It gets its name from its many delicate white blossoms, which seem to be made out of snow. Snowdrops grow in many parts of the world. They bloom in March or April in northern countries. The snowdrop is one of the special flowers for the month of January.

The plant grows from a small bulb that produces 2 or 3 narrow green leaves and a flower stalk without leaves. The nodding, bell-shaped flowers of snowdrops grow alone, one on top of each stalk. The common snowdrop of the gardens is one of the hardest outdoor plants. It sometimes blooms in midwinter when a sudden warm spell causes the surface of the ground to thaw. In England, the people call the plant the *Fair Maid of February*.

Snowdrops are easy to cultivate because the bulbs can be planted in a sheltered place in early autumn and then left to themselves. The plants require little attention.

Scientific classification. The common snowdrop belongs to the amaryllis family, *Amaryllidaceae*. It is *Galanthus nivalis*.



Snowdrop



A snowmobile moves easily over ice or snow. Snowmobiling is a popular winter sport in northern climates.

Snowflake. See Snow.

Snowmobile is a motorized sledge that carries one or two people over ice and snow. Snowmobiling is a popular winter sport in Canada, in the Northern United States, and in colder regions of Europe. The first sledge-sized snowmobiles built by mass production were made in the late 1950s.

Most snowmobiles measure from 1.5 to 2.5 metres long and about 0.75 to 1.5 metres wide. They ride on two short skis on the front of the vehicle, and a wide track (belt) toward the rear. An engine of from 6 to 75 kilowatts moves the track, propelling the snowmobile forward. The operator steers with handlebars. Most snowmobiles can go at least 80 kilometres per hour, and some can go over twice that speed. Snowmobile operators should observe safe speeds, and they should also take other safety precautions. Careless snowmobiling can be very dangerous. It has resulted in death and serious injury.

Many environmental groups criticize snowmobiling. They believe it destroys trees and shrubs and endangers wildlife. They also declare that the noise of snowmobile engines disturbs the peacefulness of rural areas. To deal with these objections, a number of countries restrict snowmobiling to certain areas and enforce snowmobile speed limits and noise levels. In addition, manufacturers

have produced quiet models that meet strict noise regulations.

See also Eskimo (picture: Snowmobiles).

Snowshoe is a device that enables a person to walk over deep snow without sinking into it. This is possible because snowshoes distribute a person's weight over a large area. Most snowshoes are at least 90 centimetres long, and from 30 to 46 centimetres wide. They are made of a light wooden frame, bent into a long oval. Strings of animal hide are stretched across the frame.

In walking with snowshoes, the wearer moves the feet so that the snowshoes slide along the surface of the snow. The wearer gives an outward motion to the snowshoes with each step.



The snowshoe hare has a brown coat during most of the year. In the winter, it sheds this coat and grows a white one, above.

Snowshoe hare is a medium-sized hare that lives in North America. It is also called *varying hare*. Snowshoe hares live in forests and swamps of Canada and the northern United States, including Alaska. They also are found in mountains as far south as New Mexico in the west and Tennessee in the east. Snowshoe hares have large, hairy hind feet for hopping over snow.

Adult snowshoe hares measure up to about 50 centimetres long. Most weigh about 1.5 kilograms. For most of the year, a snowshoe hare has a brown upper coat and a whitish chin, belly, and tail. In winter, the animal sheds its coat and grows a new one. This coat is all white except for black on the tips of the animal's long ears.

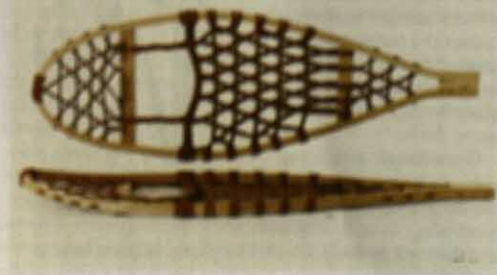
Snowshoe hares are active mainly at night. They feed on a variety of plant life, including grasses and leaves. In some areas, deep snow during winter allows them to feed on the leaves of such trees as spruces and pines. Female snowshoe hares give birth as many as four times a year. Two to four young may be born each time.

Many animals prey on snowshoe hares. Their chief enemies include snowy owls and lynx. In addition, people kill hundreds of thousands of snowshoe hares each year for food and sport.

Scientific classification. The snowshoe hare belongs to the order Lagomorpha in the rabbit and hare family, Leporidae. It is *Lepus americanus*.

See Hare.

Snowstorm. See Blizzard.



Snowshoes look like oddly shaped tennis rackets. They are made of strings of animal hide stretched over a wood frame.

Snowy is a river in southeastern New South Wales and eastern Victoria, Australia. It rises near Mount Kosciusko in the Snowy Mountains and flows for about 430 kilometres to its estuary near Orbost, in eastern Gippsland. It has a catchment area of about 12,945 square kilometres. The river became famous when the Australian poet Banjo Paterson published his poem "The Man from Snowy River" in 1895 (see *Paterson, Banjo*).

Snowy egret. See *Egret* (with picture).

Snowy Mountains are the highest part of the Australian Alps, in southeastern New South Wales and northeastern Victoria. They include Mount Kosciusko (2,228 metres), Australia's highest mountain, and Mount Townsend (2,210 metres), its second highest mountain. Sir Paul de Strzelecki explored the area in 1840.

See also *Mount Kosciusko*; *Mount Townsend*; *Snowy Mountains Scheme*.

Snowy Mountains Scheme is an immense hydroelectric and irrigation project in southeast Australia. The engineering project is so large that the American Society of Civil Engineers called it one of the *Seven Wonders of the Engineering World*.

Engineers constructed the project to provide supplementary power to the Australian Capital Territory, New South Wales, and Victoria. It also stores water, which is used to irrigate the Murray and Murrumbidgee river valleys. Work on the scheme, which covers an area of 5,200 square kilometres, began in 1949. During the next 26 years, as many as 7,300 workers from 32 countries were employed, often on three eight-hour shifts a day and working six or seven days a week, to complete the project. The workers built 16 dams, dug 137 kilometres of tunnels, and constructed 7 power stations.

The scheme also has two pumping stations and about 800 kilometres of aqueducts, as well as hundreds of kilometres of overhead power lines. The power lines conduct the electricity to centres that feed it into the power supplies of the states that receive it. The scheme was officially opened by Sir Paul Hasluck, governor general of Australia, on Oct. 21, 1972. Another four years passed before all major work was completed. The last unit of the Tumut 3 power station was finished in 1974, bringing the total generating capacity of the scheme up to 3,740 megawatts. But the bulk of the work was completed three years earlier than planned. The project began generating electricity in 1955, when Guthega power station was opened.

Benefits. The Snowy Mountains are the source of three major rivers. The Murray and Murrumbidgee flow northward and westward across the Western Plains, which are dry but fertile. The Snowy flows southward down the southern slopes of the Great Dividing Range. These slopes have ample rainfall and irrigation is not needed. The Snowy Mountains Scheme blocks the waters of the Snowy and its tributary, the Eucumbene, at high altitude and diverts them inland through two tunnel systems cut through the Snowy Mountains.

The scheme also regulates the headwaters of the Murrumbidgee, Tumut, Tooma, and Geelhi rivers. This system of dams and aqueducts allows the diverted water to fall 800 metres to pass through turbines and tunnels before reaching irrigation areas. The combined power stations generate about 6,500 gigawatt-hours (thousand million watt-hours) of electricity a year. They

provide about 12 per cent of the peak-hour power in Victoria and 13 per cent of that for New South Wales.

The water stored by the scheme allows about 2,300 gigalitres of water to be released each year for irrigation. About 40 per cent of this water goes into the Murray River. The remaining 1,300 gigalitres (thousand million litres) flow into the Murrumbidgee. Waters from the scheme have increased the amount of water available to the Murrumbidgee Irrigation Authority by a third. This increase has made possible the development of the 80,000-hectare Coleambally Irrigation Area in New South Wales.

Construction. The key to the Snowy Mountains Scheme is the conservation of waters in the upper Snowy, upper Murrumbidgee, and upper Murray catchment areas at high altitude by the creation of Lakes Jindabyne, Tantangara, and Eucumbene. The scheme is then divided into two main sections.

The Snowy-Tumut development diverts the waters of the Eucumbene, upper Murrumbidgee, and Tooma rivers into Lake Eucumbene. From there, the water flows through a tunnel into Tumut Pond Reservoir, then into the Tumut River. To complete this development, and to hold back the immense amount of water required to fill Lake Eucumbene, engineers built a dam 116 metres high and 800 metres thick at the base.

Lake Eucumbene is at an altitude of 1,200 metres. When filled, its surface area exceeds 145 square kilometres, which is more than five times that of Sydney Harbour. Its water capacity is far larger than that of Sydney Harbour. Another dam, at Tumut Ponds, regulates the flow of water to the lower Tumut.

Four power stations were built in the Tumut River Gorge, together with several other dams. The dam at Talbingo is 162 metres high, the tallest in the scheme. The 112-metre-high Blowering Dam is the second-largest water storage after Eucumbene. It holds back 1,632 gigalitres of water for later release into the Murrumbidgee.

The Snowy-Murray development. The Snowy, blocked at Lake Jindabyne, is diverted through a tunnel 13 kilometres long to the Geelhi River and then to the Swampy Plains River, a tributary of the Murray. Water from Eucumbene can also be fed into this system by a 23 kilometre tunnel. These waters then pass through the two Murray power stations before their eventual release into the lower Murray River. Water for irrigation is usually released only between September and April.

Two-way flow. An essential part of the scheme is the provision in certain sections for reversing the flow of water. During wet seasons, when far less water is needed for irrigation, engineers can direct water back into storage by reversing the direction of flow in certain tunnels. Electricity used to pump water into storage is provided by the scheme's generators. Water retained in higher-altitude reservoirs also helps maintain an ample supply to produce hydroelectricity. Unexpected peak loads, which usually occur during winter, can be met at short notice by releasing the stored water through the generators. The Eucumbene-Snowy tunnel operates as a two-way system, and Lake Jindabyne runoff can also be pumped to downstream of Island Bend.

History. In 1884, P. F. Adams, surveyor general for New South Wales, first proposed that the waters of the



Jindabyne Dam first went into service in 1967. This rockfill dam is 72 metres high, with a crest of 335 metres. The reservoir can hold nearly 690 gegalitres of water.

Snowy River should be diverted to the Murrumbidgee for use in irrigation. Many other proposals were considered during the next 60 years, but the first scheme that combined the benefits of irrigation and hydroelectricity generation was submitted in 1944. That original scheme, which called for 16 power stations and 800 kilometres of open aqueducts, was subsequently changed. In July 1949, the Australian government passed the Snowy Mountains Hydro-Electric Power Act, committing itself to the project. On Aug. 1, 1949, Sir William Hudson was appointed commissioner of the Snowy Mountains Authority. Work began on construction of the Guthega Dam, tunnel, and power station in September 1951. The first power from that station was supplied to the New South Wales system in 1955.

To undertake the building of this complex of dams, tunnels, and power stations, contractors had to be obtained from all parts of Australia and from other countries as well. To house the work force, seven regional townships, 1,000 camps, and more than 1,600 kilometres of roads had to be built. Activity reached a peak in 1959, when more than 7,300 workers were employed.

The tunnels cost about 1.25 million Australian dollars a kilometre to dig, and 54 workers died from rockfalls or blasting. At the peak of tunnelling, the workers on this scheme beat the world record of 110 metres in a six-day week with three shifts. They set a new record of 165 metres a week. Even at this pace, the 22 kilometre Eucumbene-Tumut tunnel took three years to build.

Work on the Snowy-Tumut development began in 1954. The upper part of this scheme was completed in eight years. The Snowy-Murray development followed, and the Eucumbene-Snowy tunnel was finished in 1965. The first units of the Murray 1 power station began producing electricity in 1966. The final tunnel was completed in 1967, and the ceremony marking completion of the scheme was held in October 1972. However, much work remained to be completed. Expenditure on the scheme for 1973 and 1974 was a further 27.7 million

Tunnels

Tunnel	Length kilometres	Diameter metres	In service
Eucumbene-Snowy	23.52	6.10	1965
Eucumbene-Tumut	22.19	6.40	1959
Murrumbidgee-Eucumbene	16.64	3.10	1961
Snowy-Geehi	14.43	6.10	1965
Tooma-Tumut	14.30	3.43	1961
Murray 1 Pressure	11.76	6.93	1966
Tumut 2 Pressure and Tailwater	11.22	6.40	1962
Jindabyne-Island Bend	9.86	3.76	1968
Guthega	4.62	5.15	1955
Murray 2 Pressure	2.46	7.47	1968
Tumut 1 Pressure	2.46	6.40	1959
Geehi River Aqueduct Tunnel	2.41	2.44	1965
Tumut 1 Tailwater	1.31	7.71	1959

Power stations

Station	Installed capacity kilowatts	In service
Tumut	1,500,000	1972
Murray 1	950,000	1966
Murray 2	550,000	1969
Tumut 1	320,000	1959
Tumut 2	280,000	1962
Blowering	80,000	1970
Guthega	60,000	1955

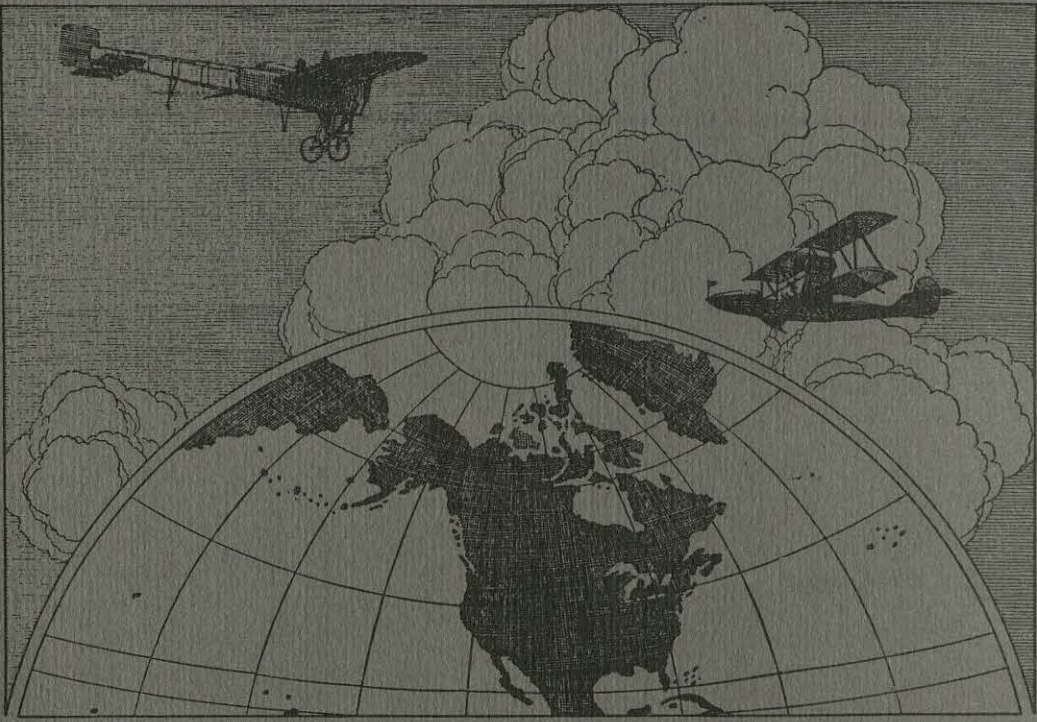
Dams

Dam	Type	Height metres	Reservoir capacity gegalitres	In service
Talbingo	Rockfill	162	920,550	1971
Eucumbene	Earthfill	116	4,799,100	1958
Blowering	Rockfill	112	1,632,400	1968
Geehi	Rockfill	91	21,106	1966
Tumut Pond	Concrete arch	86	52,818	1958
Jindabyne	Rockfill	72	689,790	1967
Tooma	Earthfill	67	28,125	1961
Island Bend	Concrete gravity	49	3,013	1965
Tumut 2	Concrete gravity	46	2,600	1962
Tantangara	Concrete gravity	45	254,080	1960
Jounama	Rockfill	44	43,800	1968
Murray 2	Concrete arch	43	2,283	1968
Guthega	Concrete gravity	33.5	1,548	1955
Happy Jacks	Concrete gravity	29	0,269	1959
Deep Creek	Concrete gravity	21	0,011	1961
Khancoban	Earthfill	18	21,512	1966

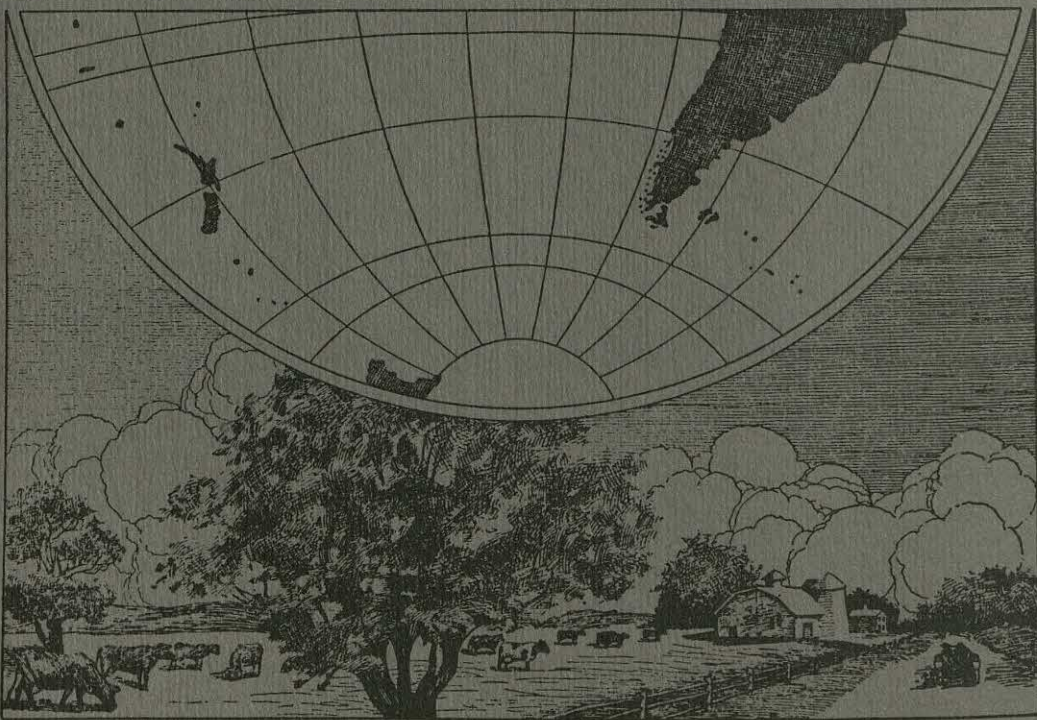
Australian dollars; 7 million dollars was spent in 1975, and 3 million dollars in 1976. On the credit side, the Snowy Mountains Scheme had earned more than 700 million dollars by 1980. It receives about 70 million dollars a year in charges for electricity supplied.

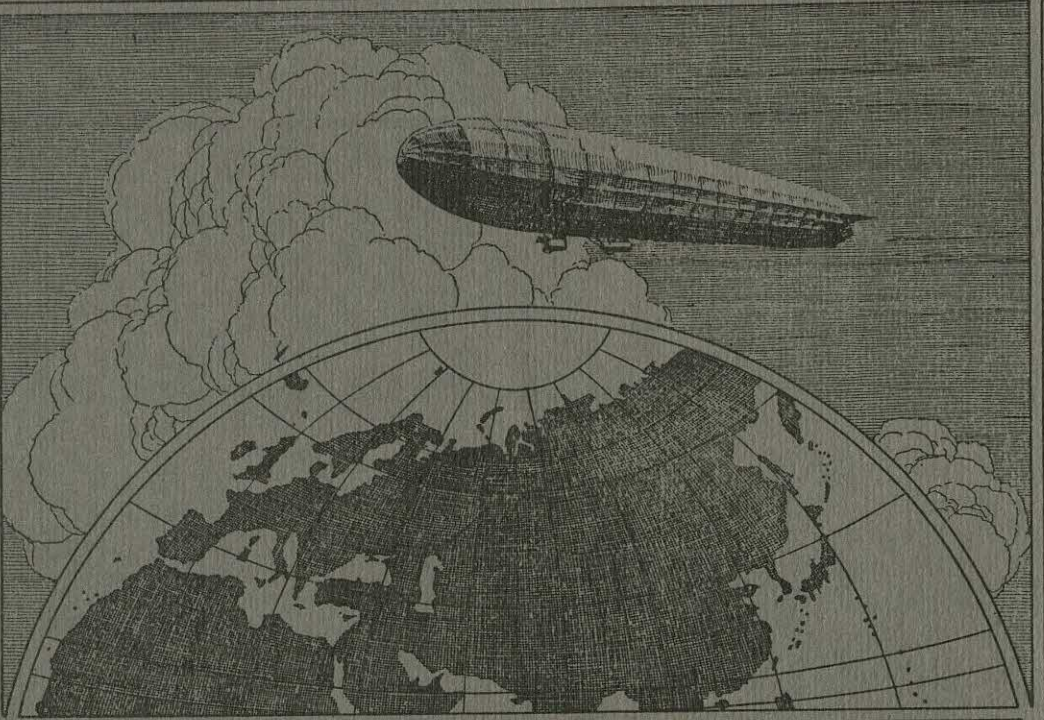
Snowy owl. See Owl (with picture).

Snuff is a moist or dry powder made from the leaves of the tobacco plant. The tobacco is first fermented by heat and moisture and then dried and ground. Moist snuff is placed between the cheek and gum. Dry snuff may be sniffed in through the nostrils, rubbed on the gums, or *dipped*—that is, placed in the mouth, usually between the gum and lower lip. Various flavourings are added to snuff to improve its taste. Taking snuff can irritate the nerves that carry the sensation of smell and lessen the ability to distinguish odours. Many doctors believe that the use of snuff increases the risk of developing cancer of the mouth and other gum diseases.



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